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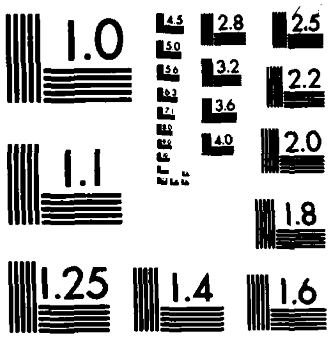

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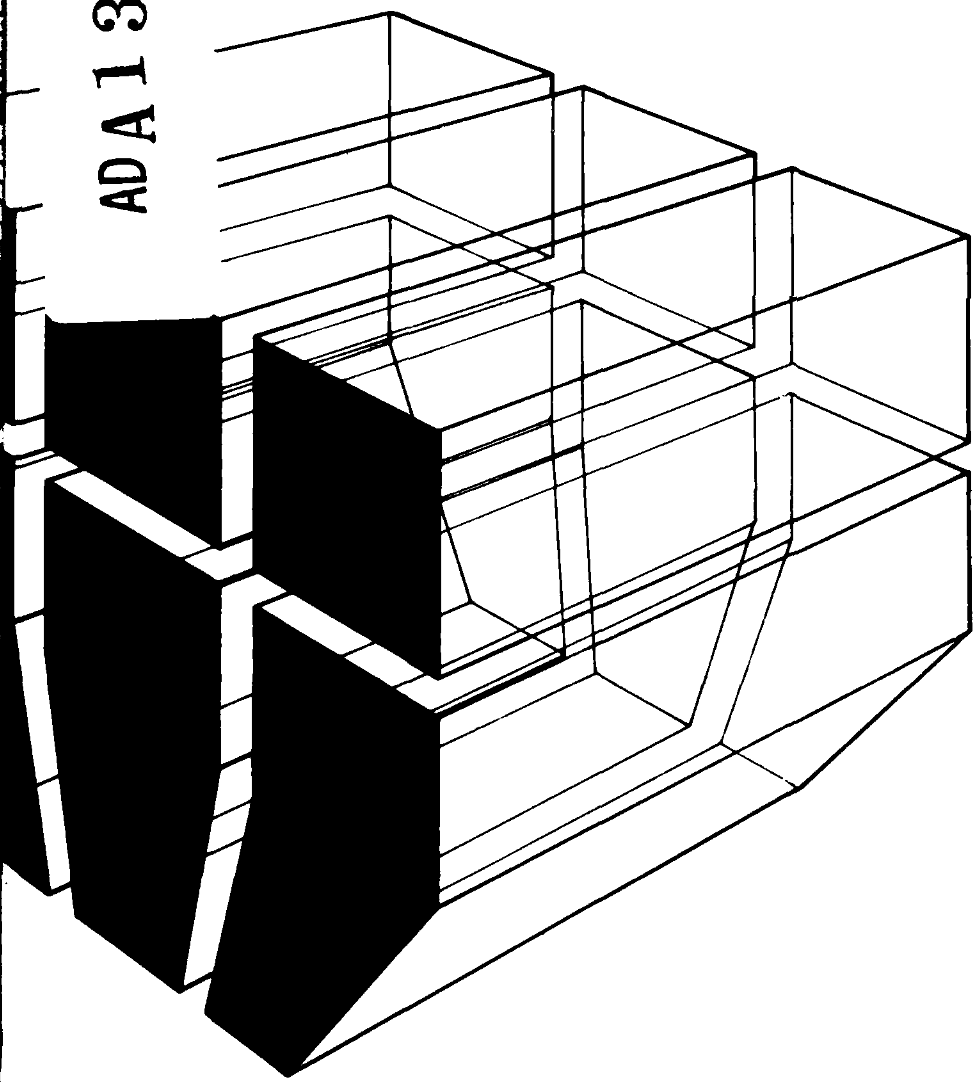
TECHNICAL REPORT E-185
May 1983
Energy Analysis Methods for Concept Design

USE OF SIMPLIFIED INPUT FOR BLAST ENERGY ANALYSIS



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This study demonstrated that a simplified input to the Building Loads Analysis and System Thermodynamics (BLAST) energy analysis computer program will generate results accurate enough for designers to use during the early stages of the Military Construction, Army (MCA) facility design process.

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FOREWORD

This work was performed for the Directorate of Engineering and Construction, Office of the Chief of Engineers (OCE), under Project 4A162781AT45, "Energy and Energy Conservation"; Technical Area A, "New Construction Energy Design Strategy"; Work Unit 002, "Energy Analysis Methods for Concept Design." Mr. Edward Zulkofske, DAEN-ECE-E, was the OCE Technical Monitor.

This research was performed by the Energy Systems (ES) Division of the U. S. Army Construction Engineering Research Laboratory (CERL). Appreciation is expressed to Ms. Linda Lawrie of CERL for her help during this study. Mr. R. G. Donaghy is Chief of CERL-ES.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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USE OF SIMPLIFIED INPUT FOR BLAST ENERGY ANALYSIS

1 INTRODUCTION

Background

The Building Loads Analysis and System Thermodynamics (BLAST) energy analysis computer program can predict hourly space heating and cooling requirements for new or existing buildings by simulating hourly fan system performance and the hourly performance of conventional, solar, or total energy mechanical equipment.[1] The BLAST program is considerably more powerful and accurate than hand calculation methods. It also gives government and government-employed architect/engineer (A/E) designers more design information about a building's peak and total energy usage. To use BLAST for such an energy analysis, the program must be given a description of the building to be modeled and its energy systems, including data on the building's geometric layout, and its wall construction, planned use, and mechanical system performance. BLAST can perform an energy analysis using a very detailed description of the facility, including exact wall and window geometry, complete wall construction and occupancy use specification, and detailed mechanical equipment performance parameters. BLAST can also perform an energy analysis using a very simplified description of the facility where exact building geometry is not considered, typical wall constructions and occupancy use profiles are used, and mechanical system parameters are defaulted to typical values.

Since BLAST can accept input for a very detailed building model and since the BLAST Users Manuals describe how to input a very detailed model, designers have assumed that a very detailed building description *must* be input for BLAST to perform a valid energy analysis. Because of this misconception, and because a building's design details are usually not available until the final design stage of the Military Construction, Army (MCA) building delivery process, BLAST has mainly been used to analyze new Army facilities that are in the final stage of the design program. But if BLAST analysis is delayed until the *final* stage of a building's design, it is impossible to reap the full benefits of BLAST's energy analysis predictions, since most decisions which affect the building's energy performance are made in the early design stages. Thus, for BLAST to be used effectively, it must be used in early design stages when details about the building's design are not available. Therefore, BLAST must accurately predict building energy use based on a minimal input description.

To demonstrate that BLAST can do a building energy analysis from a very minimal input, the U.S. Army Construction Engineering Research Laboratory (CERL) designed a study to compare the accuracy of results obtained using minimal BLAST input with those obtained using very detailed input. By showing how a simple facility description can produce results comparable to those obtained using a detailed facility description, BLAST would be proved suitable as an analysis tool for early facility design stages. Thus, designers could begin using BLAST at the point in the design process where important energy decisions are being made.

Objective

The objective of this study was to justify the use of simplified BLAST input for energy analysis.

Approach

1. Three standard Army building designs were selected for study.

2. Detailed descriptions of each standard design were obtained, including as-built drawings and facility operation data collected during onsite visits to one example of each design.

3. A detailed (baseline) BLAST input model was prepared for each building design and a BLAST annual energy analysis performed for each detailed model for a location in a mild, hot, and cold climatic region.

4. A very simple BLAST input model was prepared for each standard design and a BLAST annual energy analysis performed using the simplified model for the mild climatic location.

5. For each design, the results of the annual energy analysis using the detailed input model were compared with the results obtained using the simple input model.

6. When good agreement was not obtained between the simple and detailed model results, more detail was added to the simple model and Steps 4 and 5 repeated until good agreement was obtained.

[1] D. C. H[illegible]tle, *The Buildi[illegible] Loads Analysis and System Thermodyna[illegible]s (BLAST) [illegible]gram, Version 2.0*, Volumes I and II, Techn[illegible] Report [illegible]3/ADA072272 and ADA072273 (U. S. Army C[illegible]uction Engineering Research Laboratory [CERL], 1979).

7. After the simplest accurate model was determined for each design, that model was used to perform annual energy analyses for each design for the hot and cold climatic regions. The results were compared and the results obtained for the baseline model.

Mode of Technology Transfer

It is recommended that the results of this study be used to develop guidance for simplifying BLAST input, and that such guidance be referenced in an Engineering Improvement Recommendation System Bulletin and included in the next revision to Engineer Technical Letter 1110-3-309, *Interim Energy Budgets for New Facilities.*[2]

2 STUDY METHOD

Use of Energy Analysis Computer Programs in Energy Conservative Design

Energy efficiency is a major consideration in the design of new facilities. The Department of the Army uses two procedures to ensure that new facility designs are energy conservative:

1. Prescriptive standards like those found in the Department of Defense *Construction Criteria Manual 4270. 1-M* specify the types of materials, minimum insulation levels, amount and type of glass, and mechanical system types and operating rules which may be used for a facility design.

2. A maximum design energy consumption rate is assigned on a per square foot basis to each facility type according to climatic zones. Each actual facility design must be shown to consume no more than the amount of energy specified in the design energy budget for that facility type and climatic region.

Energy analysis computer programs like BLAST were developed to help designers create energy efficient buildings. These programs let designers evaluate design options by ranking design alternatives according to their relative energy savings. They also let designers show that their designs will comply with the appropriate design energy budget.

[2] *Interim Energy Budgets for New Facilities,* Engineer Technical Letter 1110-3-309 (Office of the Chief of Engineers, 30 August 1979).

Building Selection

To demonstrate how a simple BLAST input model could be used by Army designers to perform energy analyses during early design stages, CERL studied three facility types based on Army standard designs. (Chapters 3, 4, and 5 give a complete description of each selected facility type.)

Detailed descriptions of each design, including as-built drawings and building operation data, were collected during onsite visits to one example of each of the standard designs (see Chapter 3). These field surveys verified the as-built drawings and gathered data on building occupancy and lighting, equipment usage, and the actual operation of the heating or air-conditioning system.

Location Selection

Locations representative of mild, hot, and cold climatic regions were selected. The mild climatic regions were Columbia, MO; Forth Worth, TX; and Raleigh, NC. The cold climatic regions were Colorado Springs, CO, and Bismarck, ND. The hot climatic region was Phoenix, AZ. One year of typical actual hourly weather data was obtained for each location.

Detailed BLAST Input Model Preparation

A detailed BLAST input model was prepared for each facility selected for study. These detailed models reflected the actual construction and operation of the facility as much as possible. Each building was divided into zones according to the zoning of the heating or air-conditioning system in the actual building. Each zone's geometry and wall construction were described as they appeared on the field-verified as-built drawings. Wall coordinates* were used to describe the location of each wall in each zone and the location of each door and window on each wall. Each zone's occupancy, lighting, and equipment daily usage profiles were input as determined from design criteria and by the field survey. Energy analysis programs account for the effects of occupants on the energy consumption of a facility by allowing the program user to input profiles for the occupancy, lighting, building equipment, and thermostat settings. Designers of new facilities must approximate the effects of building occupants based

*Wall coordinates (STARTING AT's) specify the three-dimensional location of a wall in the building. When wall coordinates are used, the exact shape of the facility can be modeled and building self-shading can be accurately determined. When wall coordinates are omitted, building self-shading cannot be calculated and the simulation will assume the building has no self-shading.

on the functional specifications for the facility. Because the effect of occupants typically remains constant over all design alternatives, these approximations have little effect on the accuracy of the energy analyses. If the goal of the energy analysis is to predict the actual energy consumption of a real facility, then the occupancy effects must be precisely determined, since variations in these effects can cause significant variations in building energy consumption. Because the goal of this study was only to compare two different design analyses, the occupancy effects were not determined in sufficient detail to predict the actual annual energy consumption of these facilities. The operation of each zone's room thermostat was modeled as closely as possible to the actual operation of the thermostats as determined in the field survey. The building's heating or air-conditioning system operation (ventilation air quantities, deck set points, seasonal scheduling) was also modeled as closely as possible to the actual system's operation. Every attempt was made to include the details of each facility's design and operation into the BLAST input model.

The ability of the detailed BLAST input models for the dental clinic and the battalion headquarters and classroom building to accurately predict a building's energy consumption was verified in an earlier study.[3] This study showed that the detailed models predicted energy consumption to within 10 to 12 percent of measured energy consumption during the 6-month comparison period. Thus, the detailed BLAST input models for the three buildings accurately reflect the design and operation of the facilities and accurately predict their energy performance.

Annual Energy Simulations Using the Detailed BLAST Input Models

To develop baseline energy consumption data for each facility, the detailed BLAST input models were used to perform annual simulations of the facilities in at least one location for each of the three climatic regions (mild, hot, and cold). Simulation results included:

1. The annual heating and cooling demands for the zones (i.e., the total amount of heating or cooling which must be supplied to the zones to keep them at a specific temperature).

2. The annual heating and cooling demands of the fan systems (i.e., the amount of hot and chilled water which must be supplied to the fan systems to provide the necessary heating and cooling to the building and to provide ventilation air).

3. The annual total energy consumption of the building, including energy for the heating or air-conditioning system and the building's lights and equipment.

Simplified BLAST Input Model Preparation

The most simple BLAST input models possible were developed for each of the chosen facilities. Each model contained only the minimum information needed to ensure that all aspects of the facility's energy consumption had been addressed. Each building was divided into the fewest number of zones that would reflect the operation of the building (e.g., space which was not cooled could not be grouped with space which had cooling). All walls of a zone with the same construction type and facing angle were combined into a single wall as were windows, doors, roofs, and floors. Wall coordinates were not specified. Interior partitions within a zone were combined and described as internal mass. Zone occupancy, lighting, and equipment amounts were combined when operating schedules were similar. The heating or air-conditioning system models were simplified to reflect fewer zones. These simplified models substantially reduced the amount and the detail of the input compared to the baseline model.

Annual Energy Simulations Using the Simplified BLAST Input Model

The simplified BLAST input models were used to perform annual energy simulations for the mild climatic location where the baseline (detailed) simulations had been performed. Simulation results included the same data as the baseline simulation results.

Comparison of Simplified and Detailed Simulation Results

If a simplified input model is to be used during early design stages to assess a facility's energy performance, then the model must accurately predict the zone heating and cooling requirements so the energy impacts of architectural modifications can be addressed. It must also accurately predict system and total energy consumption so the energy impacts of mechanical system design changes can be identified. Thus, for each facility, the results of the detailed and simplified simulations for the mild climatic location were compared. To ensure the accuracy of the simplified model,

[3] D. Herron, *Comparison of Building Loads Analysis and System Thermodynamics (BLAST) Computer Program Simulations and Measured Energy Use*, Technical Report E-174/ADA105162 (CERL, 1981).

this comparison included data for the zone heating and cooling loads, system heating and cooling energy demands, and total energy consumption.

Improvements to the Simplified BLAST Input Models

When the data comparison showed that good agreement was not obtained between the simplified and detailed model for the mild climatic location, the simplified model was revised and the simulation and data comparison repeated. These revisions mainly involved increasing the number of zones in the simplified model to account for interior versus exterior space, or for areas with high internal loads. Detail was added to the simplified model until good agreement with the baseline model was obtained.

After a valid simplified model was created for each facility (based on the simulation results for the mild climatic region), the simulations were repeated for the hot and cold climatic regions for each facility. These data were then compared with the results obtained using the baseline model.

3 ROLLING-PIN-SHAPED BARRACKS: ANALYSIS AND FINDINGS

Building Description

A detailed description of the two-company, rolling-pin-shaped barracks for enlisted personnel was obtained from the as-built drawings and a field survey of a barracks located at Fort Bragg, NC. The barracks is a three-story building with 40,698 sq ft of floor area. The exterior walls are 4-in. face brick with 2 in. of air space and 4 in. of concrete block. There are 16,061 sq ft of exterior wall and 4399 sq ft of single-pane glass. The building volume to external surface area ratio is 6.63. The ground floor consists of 4 in. of stone, an airspace, and 4 in. of concrete. There is a built-up roof with 1/2-in. stone, 3/8-in. felt and membrane, 2 in. of dense insulation, and 4 in. of concrete. Each barracks houses 204 persons. Figure 1 is a line drawing of the first floor of the barracks. The barracks does not have any core area; it is heated and cooled by fan/coil units which receive their hot and chilled water from a remote central plant. Except for a small electric load, the only internal loads are people and lights. The external load through the walls, windows, roof, floor, and infiltration is the primary load for the heating and cooling system.

Detailed BLAST Input Model

To determine the simplest possible BLAST input model for the rolling pin barracks, a detailed BLAST model of the building was developed. The building was divided into 18 zones. Each floor had six zones (Figure 2). The numbers and sizes of the rooms within a zone determined the zone's occupancy. Lighting was based on the zone's floor area. The amount of infiltration used was 0.8 air changes per hour. The temperature control used in the building was full heating below 68°F during the heating season and full cooling above 78°F during the cooling season. The amount of heating and cooling for each zone in the detailed model was sized to meet the most extreme heating and cooling demands of the coldest and hottest climatic locations: Colorado Springs, CO, and Phoenix, AZ, respectively. Appendix A lists the BLAST input description for the detailed model. This model was used to perform a BLAST simulation in each of the five locations. The results of these analyses are shown in Table 1.

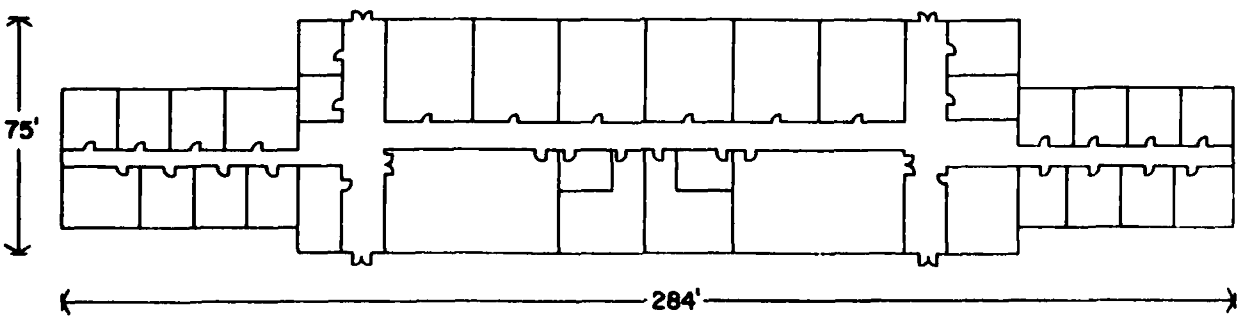

Figure 1. Line drawing of two-company rolling-pin-shaped barracks' first floor plan.

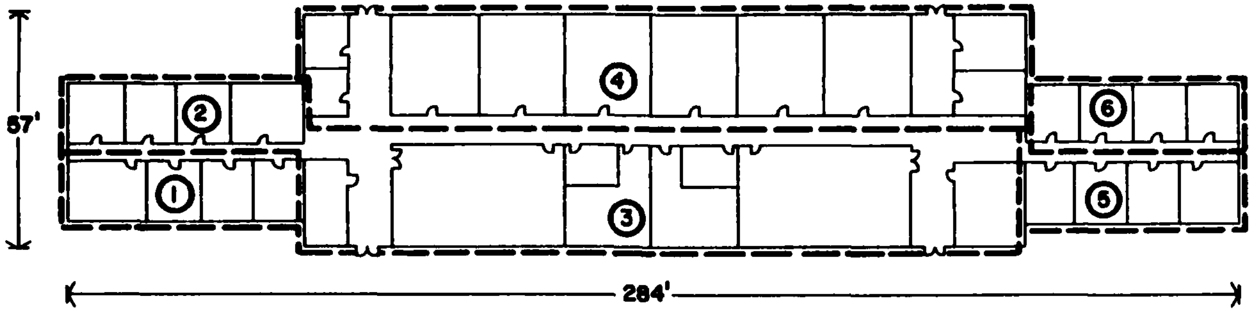

Figure 2. First floor divided into six zones.

Table 1
Analysis Results – Rolling Pin Barracks

	Zone Loads (10^6 Btu) Heating		Cooling		System Loads (10^6 Btu) Heating		Cooling		Total Energy (10^6 Btu)	
	Sum	%Δ	Sum	%Δ	Sum	%Δ	Sum	%Δ	Sum	%Δ
Colorado Springs, CO										
Detailed	1881	--	295	--	3324	--	262	--	4330	--
One zone	1947	4	256	−13	3322	0	241	−8	4330	0
Two zones	1925	2	281	−5	3343	1	250	−5	4290	−1
Columbia, MO										
Detailed	1772	--	545	--	2919	--	704	--	4360	--
Two zones	1813	2	526	−3	2948	1	649	−8	4330	−1
Raleigh, NC										
Detailed	1095	--	566	--	1972	--	767	--	3480	--
Two zones	1133	3	544	−4	1993	1	700	−9	3430	−1
Fort Worth, TX										
Detailed	724	--	1024	--	1371	--	1396	--	3510	--
Two zones	752	4	1002	−2	1376	0	1306	−6	3420	−3
Phoenix, AZ										
Detailed	251	--	1693	--	667	--	1987	--	3400	--
Two zones	270	8	1679	−1	671	1	1934	−3	3350	−1

Simplified BLAST Input Model

After the detailed model results were obtained, the simplest possible BLAST input model was developed. The entire building was modeled as a single zone. All the exterior walls and windows facing the same direction were lumped together. Wall coordinates (STARTING AT's) were not used. Partitions were described as internal mass. The overhangs were widened so they had the same shading angle with the windows as before. If the amount of people and lights had the same schedule, they were combined. The heating and cooling capacities were combined when rooms had the same temperature control profile. Appendix A shows the one-zone BLAST model. This one-zone model was used to simulate the building in Colorado Springs. Table 1 shows that the one-zone model does not simulate the building nearly as accurately as the 18-zone model. This is probably because of the building's east-west orientation. Since the south side will get more sun than the north side, the south-side zones will need more cooling and less heating than the north-side zones. The one-zone model does not separate the south and north sides. Instead, the north- and south-side loads are mixed, which cancels some of the load.

Improved Simplified BLAST Input Model

Because the one-zone model was not satisfactory, a two-zone model was developed. The building was divided into a north and south zone. As before, all wall areas, window areas, people, and lights were combined based on the rooms that made up each of the two zones. "STARTING AT's" were not used since the building had only minor amounts of self-shading. Appendix A lists the two-zone BLAST description. Figure 3 compares the building heating

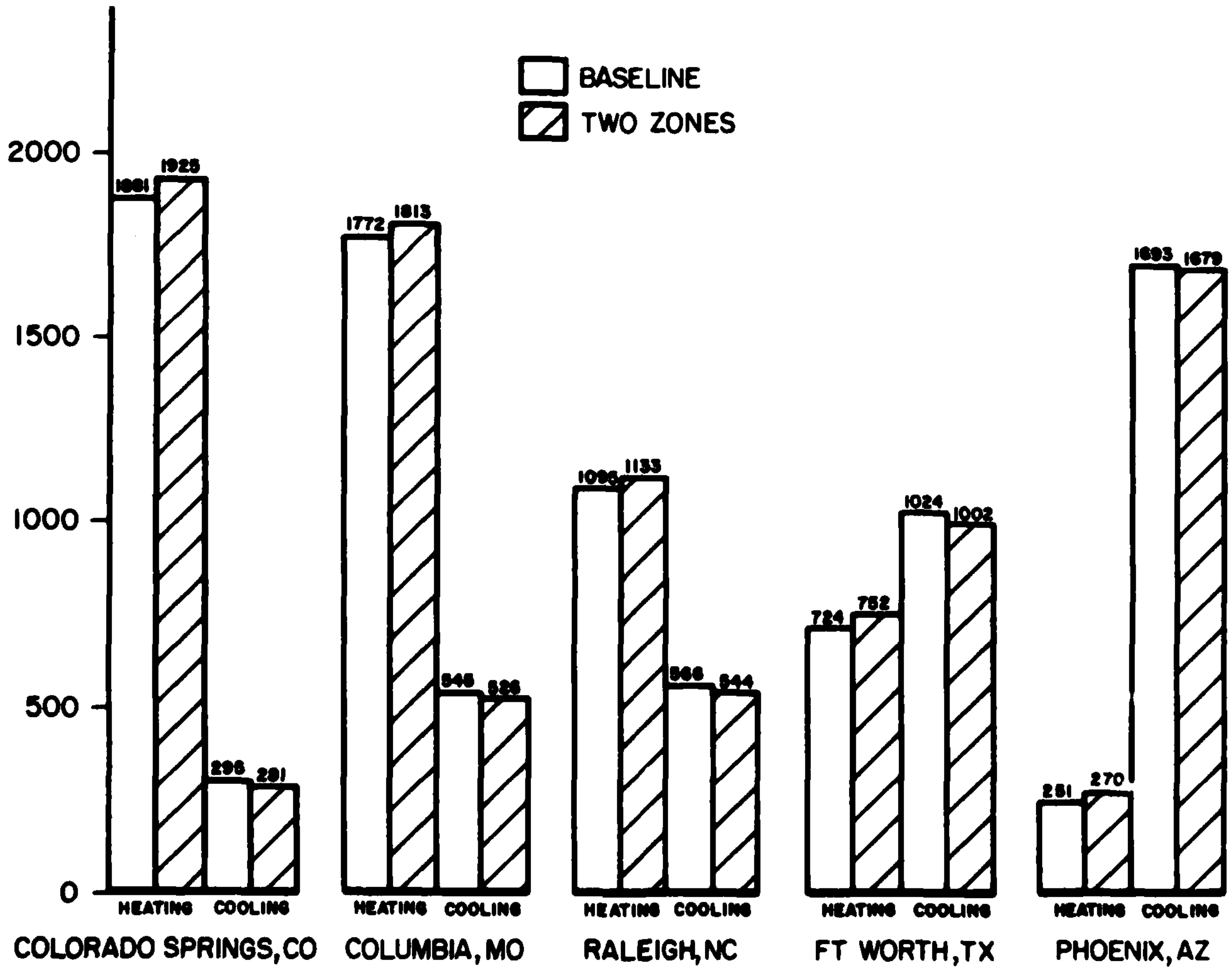

Figure 3. Two-zone model for rolling pin barracks building loads compared with the detailed model's building loads for five locations.

and cooling loads for the two-zone model with the detailed model for all five locations. The two-zone model results agree with the detailed model results to within 5 percent at all locations, except for the heating load in Phoenix, which is 8 percent too high. Because there is a small heating load in Phoenix, a small difference between the models can cause a relatively large percentage error. The cooling load is small in Colorado Springs, and this small difference results in the second largest error (5 percent). As shown in Figures 4 and 5, the system heating and cooling loads and the barracks' total energy consumption, respectively, show good agreement between the two-zone simplified model and the detailed model.

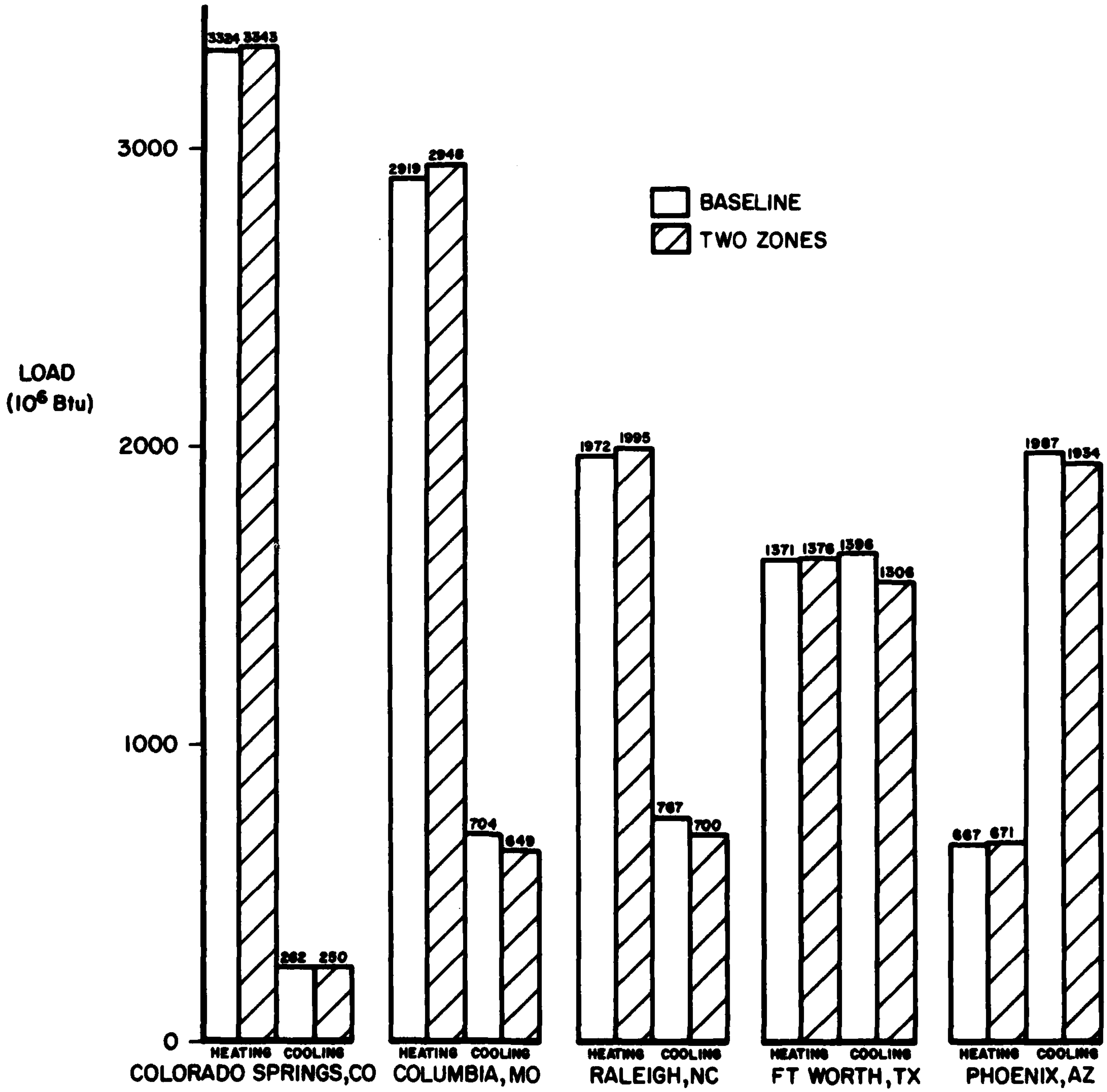

Figure 4. Two-zone model's system loads for the rolling pin barracks compared with the detailed model's system loads for five locations.

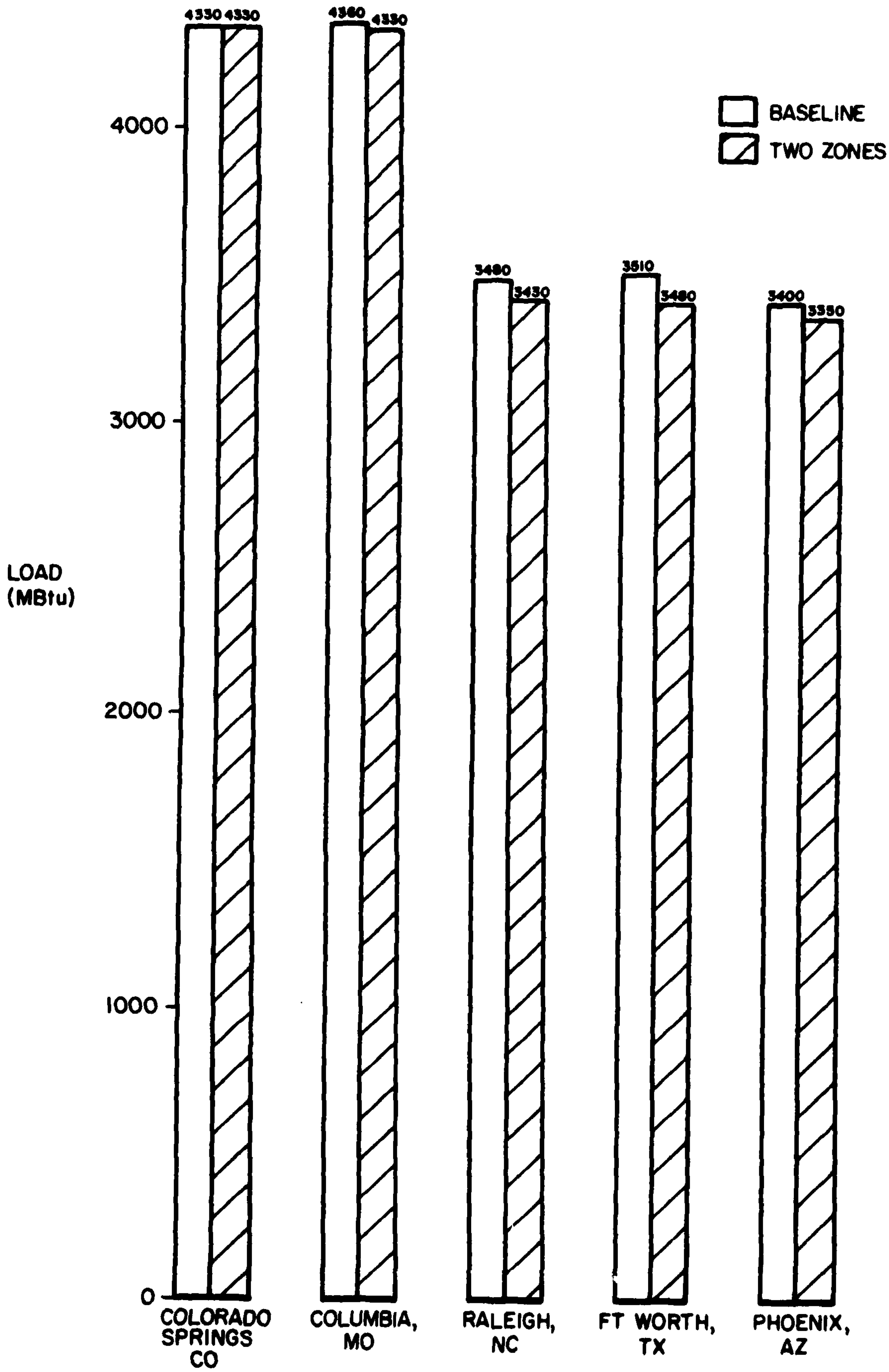

Figure 5. Two-zone model's total energy for the rolling pin barracks compared with the detailed model's total energy for five locations.

Use of Simplified BLAST Input Model for Retrofit Analysis

The detailed model and the two-zone models were also run for selected energy conservation retrofit options. Table 2 describes each retrofit option; Table 3 and Figure 6 compare the simulation results of the detailed model with the results for the two-zone model for each retrofit option.* The numerical differences between the detailed retrofit models and the detailed baseline models are usually the same as the difference between the two-zone detailed and retrofit models. Most important, the simplified models always rank the retrofit options in the same order. The difference in terms of energy savings is nearly the same.

*It may appear that some of these retrofits use more energy. This is true for the zone loads, but the system loads actually decrease.

Table 2
Description of the Retrofits for the Rolling Pin Barracks

Retrofit	Description
R1	Block vents with 2 in. of blueboard insulation, rubber sealant, and 1/8 in. of aluminum plate. Also reduce bathroom exhaust by 50 percent.
R2	Fill the wall's 2-in. cavity with R = 10 sq ft - hour °F/Btu sprayed-in insulation.
R3	Add storm windows made of 1/8-in.-thick glass.* Assume that infiltration is reduced 20 percent by adding storm windows.

*This may not be practical for barracks with casement windows.

Table 3
Total Energy Consumed (10^6 Btu) for Three Retrofit Options for the Rolling Pin Barracks at Five Locations

	Baseline			R1			R1 + R2			R1 + R2 + R3		
	Sum	Savings (10^6 Btu)	% Δ Detailed	Sum	Savings (10^6 Btu)	% Δ Detailed	Sum	Savings (10^6 Btu)	% Δ Detailed	Sum	Savings (10^6 Btu)	% Δ Detailed
Colorado Springs, CO												
Detailed	4330	--	--	3570	−760	--	2900	−1430	--	2300	−2000	--
Two zones	4330	--	0	3600	−730	1	2930	−1400	1	2320	−2010	1
Columbia, MO												
Detailed	4360	--	--	3850	−510	--	3240	−1120	--	2700	−1660	--
Two zones	4330	--	−1	3850	−480	0	3230	−1100	0	2690	−1640	0
Raleigh, NC												
Detailed	3480	--	--	3050	−430	--	2620	−860	--	2230	−1250	--
Two zones	3430	--	−1	3030	−400	−1	2600	−830	−1	2200	−1230	−1
Fort Worth, TX												
Detailed	3510	--	--	3090	−420	--	2690	−820	--	2340	−1170	--
Two zones	3420	--	−3	3060	−360	−1	2650	−770	−1	2290	−1130	−2
Phoenix, AZ												
Detailed	3400	--	--	2950	−440	--	3670	−730	--	2340	−1060	--
Two zones	3350	--	−1	2930	−420	−1	2640	−710	−1	2300	−1050	−2

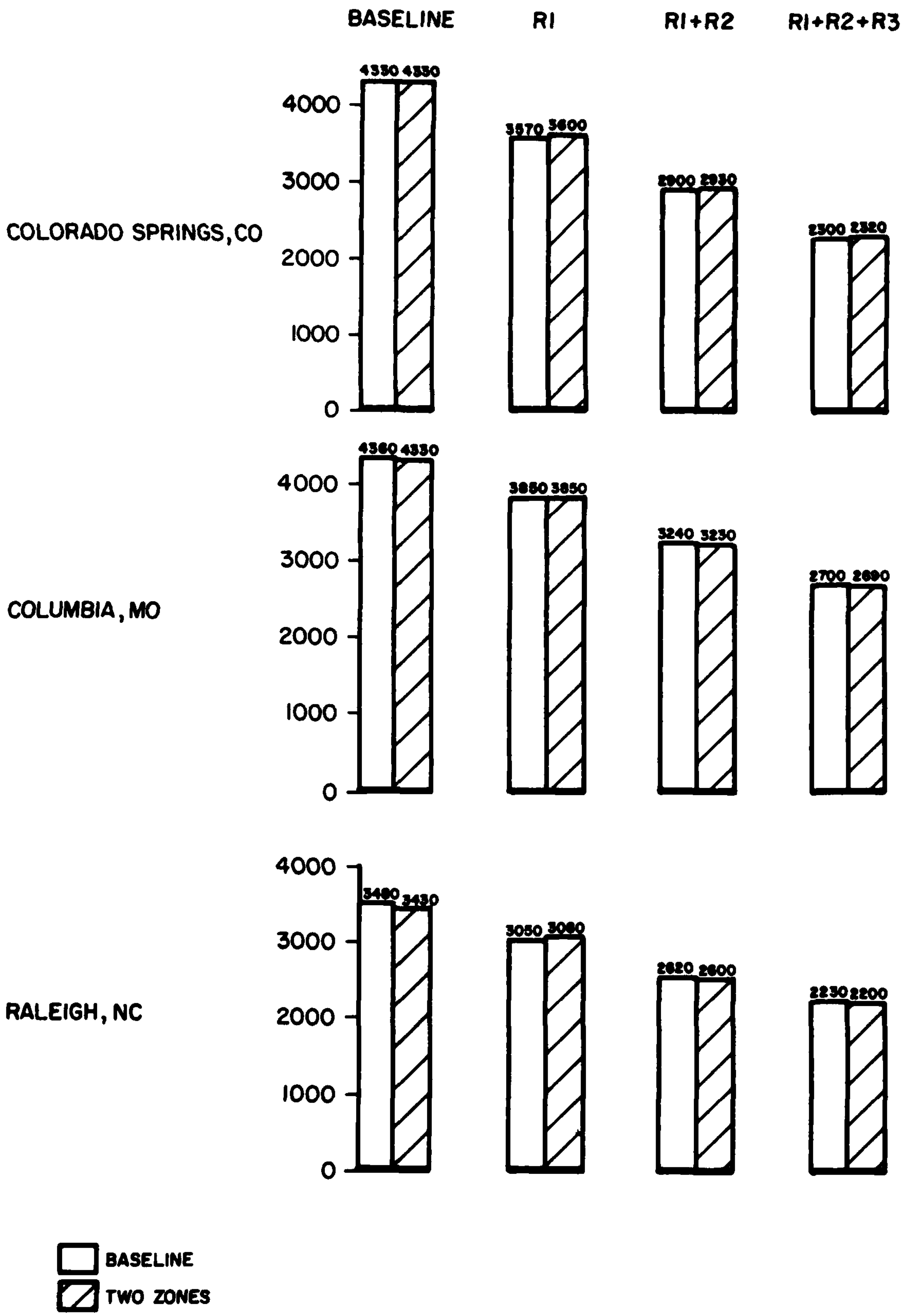

Figure 6. Simulation results of the retrofit models for the rolling pin barracks.

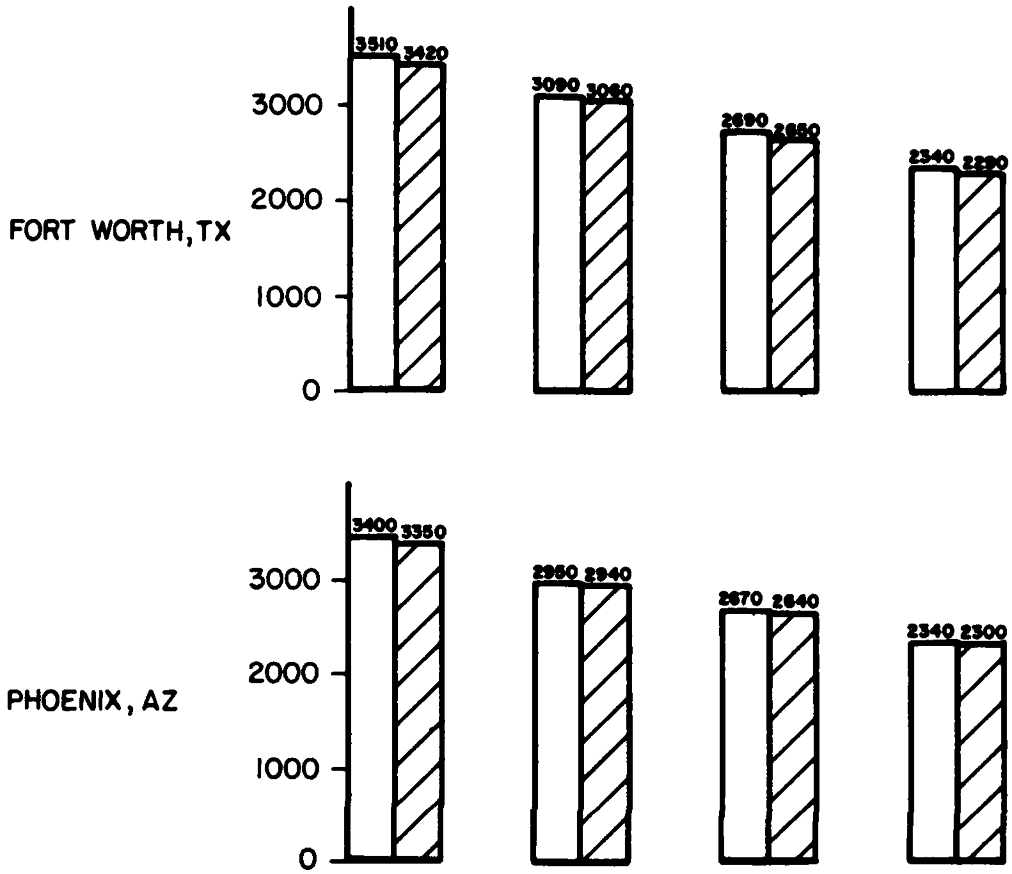

Figure 6. (con't)

Effect of Infiltration on the Accuracy of the Simplified Model

To determine how increased infiltration affects simulation results, an alternate detailed model was developed that included higher infiltration rates. The simulation was repeated with this model for four locations.* The infiltration rate was 1.5 air changes per hour in Bismarck, ND. The other locations had infiltration rates of 2.3 air changes per hour. The one-zone model was also revised to include the increased infiltration. As shown in Figure 7, a one-zone model was accurate enough to describe this detailed model.

*The other model more realistically represents a rolling-pin-shaped barracks.

Figure 7 shows the total energy consumption for both the detailed and one-zone models at all locations. Also shown in the figure are the results obtained using a one-zone model where the number of people and lights are rounded off. Both a dorm operating schedule and a 68 to 78°F deadband temperature control were used. This model is the simplest possible model which could be developed. While this approximate one-zone model is not very accurate, it does predict the energy consumption to within 35 percent. The higher infiltration rate is the reason that a one-zone model accurately simulates the building. Since the one-zone model was not far off in the low-infiltration building, increased infiltration makes all the zones even more thermodynamically similar, such that one zone is sufficient.

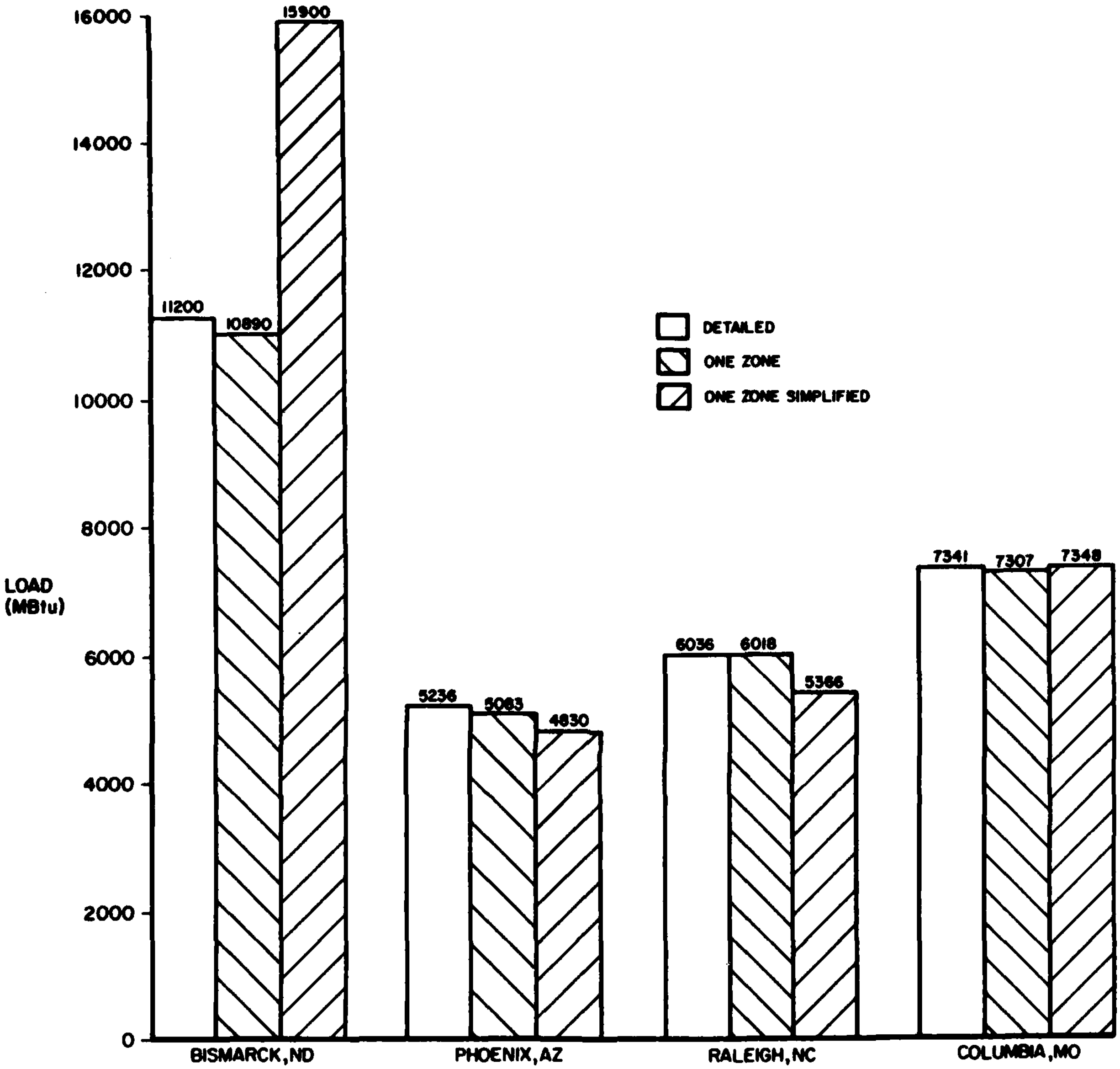

Figure 7. Total energy consumption for the rolling pin barracks – high infiltration.

Effect of "STARTING AT's" on the Accuracy of the Simplified Model

Using the alternate detailed model, the two-zone model, and the one-zone model, the effect of not using "STARTING AT's" for the Raleigh, NC, location was tested. Figure 8 shows that there was no change in simulation results when the "STARTING AT" phrase was removed. This is because the building has very little self-shading.

Summary

The rolling pin barracks can be accurately simulated in two zones by dividing the building into north- and south-facing zones. The simplified zone model combines all the exterior wall and window areas within each zone, plus loads produced by people, lights, and infiltration. It also includes partitions as building internal mass. If retrofit options are simulated, the simplified model will respond in the same way as the detailed model. The retrofit options will be ranked in the same order by either the simplified or detailed model. The energy savings are about the same with either model. Infiltration is an important factor in deciding how many zones are needed to describe a building. If the infiltration rate is doubled, a one-zone model will accurately simulate the building.

Discussion of Results

The simplification of the BLAST input deck discussed in this chapter can be applied to the analysis of other facilities. Some of the general conclusions which can be drawn are:

1. Multistory buildings of similar design do not have to have each floor modeled as a separate zone. Instead, the building should be modeled as one or more tall zones equal in height to the total building height. The number of zones will depend on the building's configuration, orientation, and use pattern.

2. Individual rooms can be grouped into one large zone if their use patterns and internal loads are similar.

3. Interior partitions can be ignored as long as their mass is accounted for.

4. The actual locations of walls, windows, and doors are not needed unless some parts of the building shade themselves. In fact, the actual shapes of walls, windows, and doors are immaterial so long as all the area and the orientation have been accounted for.

5. South-facing rooms will have to be grouped into a separate zone from north-facing rooms if there is a significant amount of glass (> 10 percent of wall area). This accounts for the use of two zones instead of one zone in the barracks model.

The rolling pin barracks energy loads are dominated by the building envelope. That is, the heating and

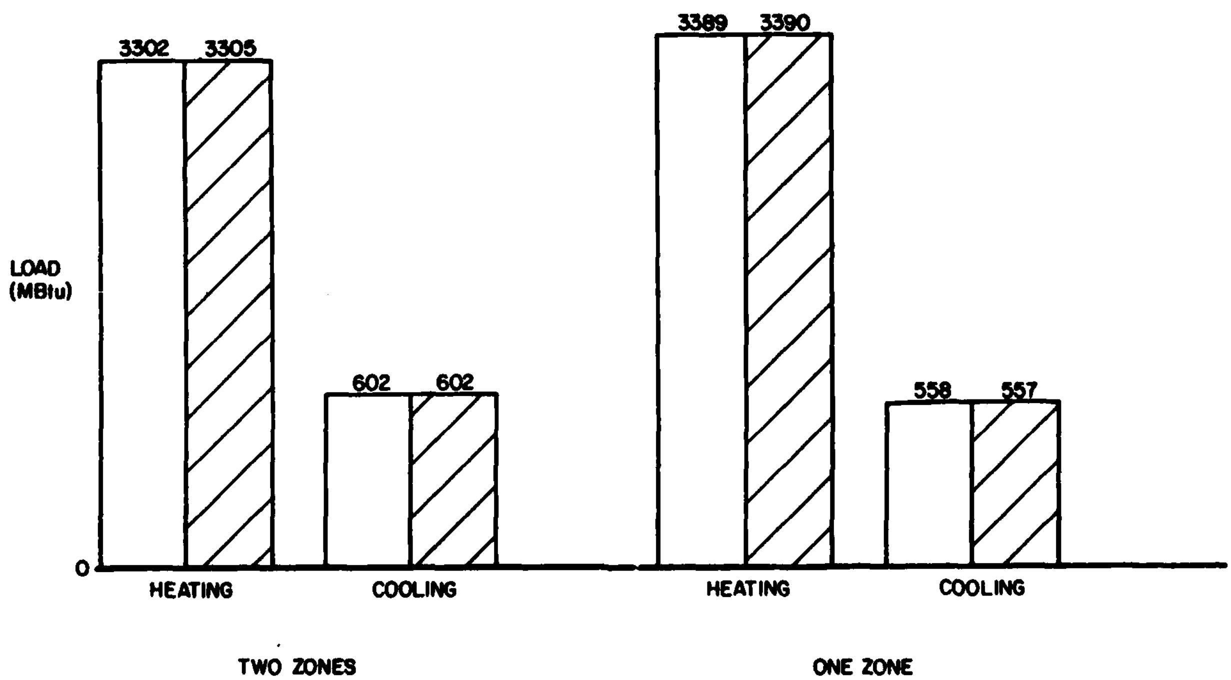

Figure 8. Zone loads – STARTING AT removed from rolling pin barracks simulation at Raleigh, NC.

cooling requirements of the barracks are determined mainly by the characteristics of the building envelope, since the loads from people, lights, internal equipment, and ventilation are minimal. Several other Army standard building types, including warehouses, maintenance shops, gymnasiums, and commissaries, have similar characteristics. Thus, similar reductions in the amount of detailed information required to produce valid BLAST analysis of these facilities should also be possible.

4 BATTALION HEADQUARTERS AND CLASSROOM BUILDING: ANALYSIS AND FINDINGS

Building Description

A detailed description of the battalion headquarters and classroom building was obtained from as-built drawings and a field survey of a battalion headquarters and classroom building located at Fort Carson, CO. This building is a one-story structure with a ground floor area of 18,907 sq ft and a partial basement area of 3300 sq ft. The building is 259 ft long, 73 ft wide, and has an exterior wall area of 8235 sq ft. Figures 9 and 10 show a floor plan and typical wall, roof, and floor sections, respectively. The building core is served by a seven-zone multizone air-handling system which receives hot and chilled water from a remote central plant. The temperature in the core area is maintained at 74°F during the heating season and at 78°F during the cooling season. The storage areas at each end of the ground floor and the basement are served by single-zone, heating-only systems which also receive hot water from a remote central plant. They are kept at 74°F during the heating season. Sixteen people occupy the facility during normal working hours with 25 additional persons occupying each of the classrooms for 2 hours each weekday. Four persons occupy the facility at night and on weekends.

Detailed BLAST Input Model

Based on the data gathered from the as-built drawings and the field survey, a 10-zone detailed model of the battalion headquarters and classroom building was prepared. The model's 10 zones correspond to the building's 10 actual heating and air-conditioning zones. (Figure 11 shows the location of the nine first-floor zones.) The basement is modeled as a single zone. Walls and windows were input at their exact locations as determined from the as-built drawings. Zone occupancy and lighting levels were input as determined by the building survey. Infiltration was assumed to be zero, since the building was positively pressurized by the fan system. This system operated continuously and introduced about 7000 cfm of ventilation air. Appendix B lists the detailed BLAST input model.

BLAST simulations were performed using the detailed (baseline) BLAST model for three locations: Raleigh, NC; Bismarck, ND; and Phoenix, AZ. The results, given in Table 4, show how inefficient the multizone air-handling system used in the building is. The energy required by this system is between seven and 23 times the load needed by the building. This is inherent in the design of multizone systems, which are required to simultaneously heat and cool. The total energy consumed by a multizone air-handling system depends almost entirely on the type of system, and very little on the design of the structure.

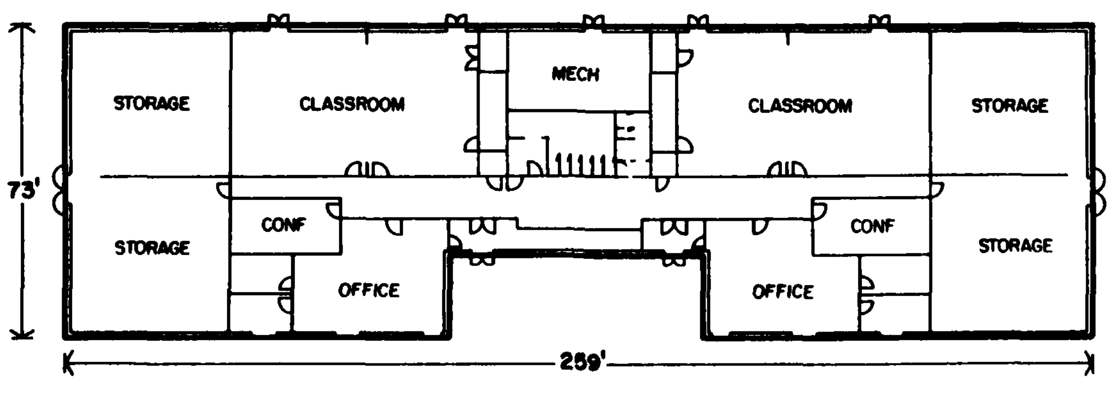

Figure 9. Battalion headquarters and classroom building floor plan.

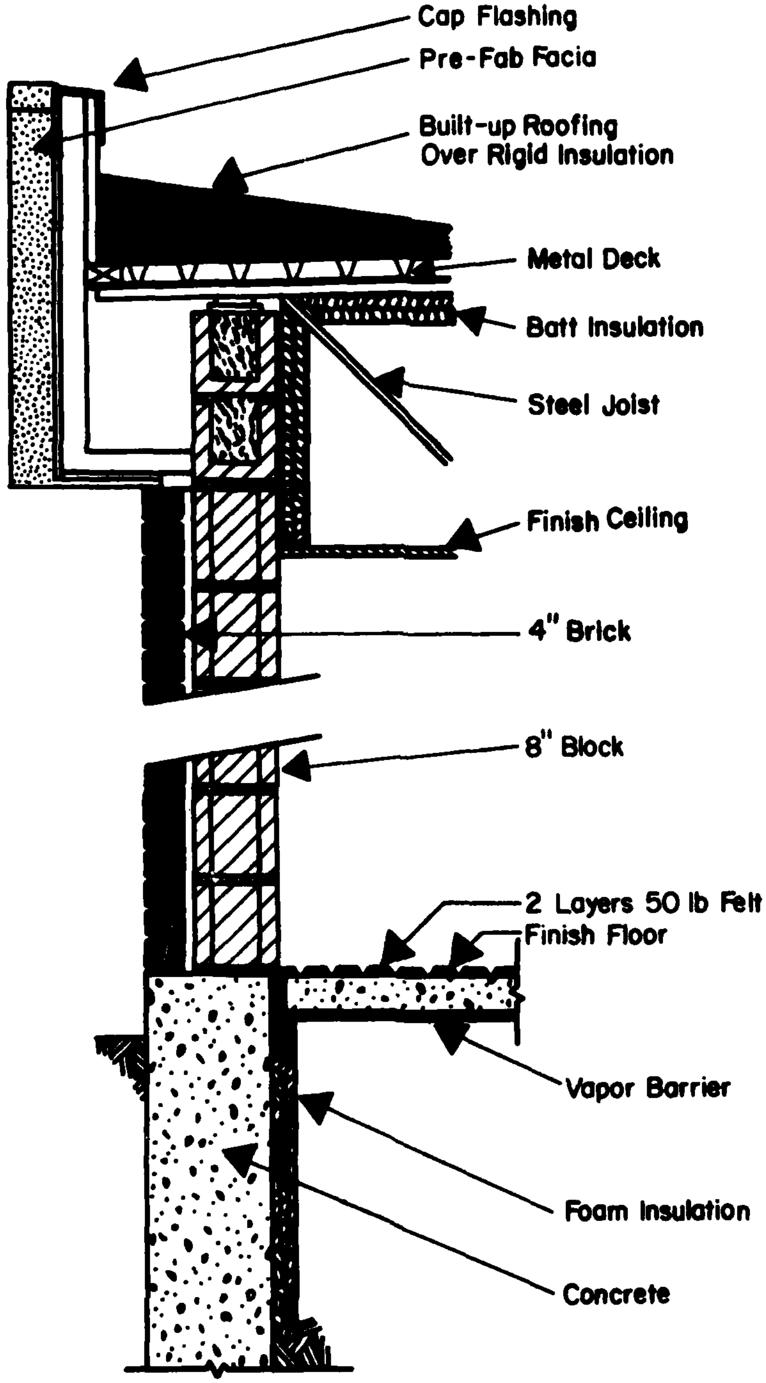

Figure 10. Battalion headquarters and classroom wall, floor, and ceiling details.

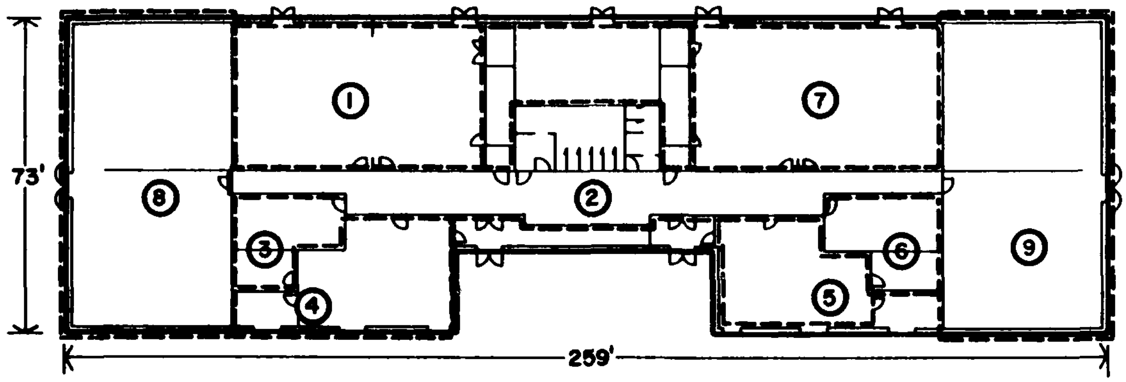

Figure 11. Battalion headquarters and classroom building floor plan showing first-floor zones.

Table 4
Comparison of Loads Calculated From Simplified Models With Loads Calculated From Baseline Model for the Battalion Headquarters and Classroom Building

	Zone Loads (10^6 Btu) Heating		Cooling		System Loads (10^6 Btu) Heating		Cooling		Total Energy (10^6 Btu)	
	Sum	% Δ Baseline	Sum	% Δ Baseline	Sum	% Δ Baseline	Sum	% Δ Baseline	Sum	% Δ Baseline
Raleigh, NC										
Baseline	284	--	149	--	3924	--	1059	--	5763	--
Three zones	269	-5	125	-16	3927	0	1058	0	5760	0
Four zones	284	0	134	-10	3930	0	1055	0	5765	0
Five zones	285	0	142	-5	3926	0	1056	0	5761	0
Bismarck, ND										
Baseline	908	--	70	--	7186	--	446	--	8435	--
Five zones	915	1	65	-7	7189	0	443	-1	8436	0
Phoenix, AZ										
Baseline	96	--	344	--	2300	--	1169	--	4223	--
Five zones	95	0	334	-3	2303	0	1164	0	4219	0

Simplified BLAST Input Model

After the detailed BLAST model was complete, the simplest possible BLAST input model for the battalion headquarters and classroom building was developed. Because the building has a basement area and heated-only storage areas on the main floor, a one- or two-zone model was not likely to give good results, since areas which had cooling and heating would have to be combined with heated-only areas. Thus, the simplest possible BLAST input model has three zones: one zone for the heated and cooled space, one zone for the heated-only first floor storage areas (zones 8 and 9 in Figure 11), and one zone for the basement. Appendix B lists this simplified three-zone model. All walls, windows, doors, roofs, and floors with the same construction and orientation were combined. Because the building is basically rectangular, self-shading was not important. Wall coordinates were not specified. The people, lighting, and building equipment loads were obtained for each of the three zones by combining the loads from each zone of the detailed BLAST input model. Similarly, the zone heating or cooling capacities were determined by combining the capacities used in the detailed model.

The three-zone model was tested for Raleigh, NC. Although the prediction of total energy consumed is very accurate (Table 4 and Figure 12), the three-zone model is, in fact, not a good model. This is evidenced by the zone loads shown in Table 4.

There is virtually no difference between the three-zone model results and the baseline results for total energy consumed or for the system and zone heating loads. However, the zone cooling loads for the three-zone model are 16 percent lower than the baseline. To have a model that accurately compares variations in the zones and systems, zone and system loads and final total energy consumed must be accurate. Figure 13 compares the zone loads for the two models.

Improved Simplified BLAST Input Model

Because the three-zone model was inadequate, a four-zone model was developed (see Appendix B). The hallway (zone 2 in Figure 11) has very little internal load, and is dominated by conditions in the zones around it. Since its load characteristics were distinctly different from the other individual zones, it was modeled as a separate zone.

The four-zone model was tested for Raleigh, NC. Once again, the total energy consumed and the system loads were the same as the baseline. The zone cooling load, although improved, was still not accurate enough (Table 4 and Figure 13).

To develop the next model, the interior zones (zones 3 and 6 in Figure 11) which had a similar number of hours of heating and of cooling were grouped into a separate zone. This created a five-zone model. This model appeared feasible because it separated the basement, the storage areas, the hall, the external spaces (offices and classrooms), and internal space (conference rooms). The loads, capacities, and surfaces were also grouped. The wall coordinates were omitted, as in all the simplified models. (The input description for the five-zone model is given in Appendix B.) The increase in detail from the four-zone model to the five-zone model reduced the percentage difference in the zone cooling load between the baseline and simplified models to 5 percent. All loads were within 5 percent of the baseline (Table 4 and Figures 12 and 13). Therefore, the five-zone model was considered the simplest accurate model.

The five-zone model was tested for two other locations (Bismarck, ND, and Phoenix, AZ) to verify it in more severe climates. Figures 12 and 13 show the results of those tests. Bismarck showed a 1 percent difference from the baseline in system cooling load and in zone heating load. The zone cooling for Bismarck was 7 percent lower than the baseline, but the cooling load for Bismarck was so small that a 7 percent difference is not significant. With Phoenix weather data, the total energy consumed, system loads, and zone heating load showed virtually no difference between the baseline and the five-zone model. The zone cooling load for the five-zone model was 3 percent lower than the baseline.

Effect of Internal Mass on the Accuracy of the Simplified BLAST Input Model

The internal mass and the mass in the walls were eliminated from the detailed and five-zone models to see the effect of mass on the loads. The mass can be removed from the walls by describing surfaces by R-values only. Both the detailed and the five-zone models without mass were run with Raleigh, NC, weather data and were found to be very inadequate. By removing the mass, the zone heating load increased by about 20 percent, the zone cooling by about 30 percent, the system heating by 2 percent, the system cooling by 3 percent, and the total energy consumed by 3 percent (Table 5). The effect, however, was the same on both the detailed and simplified models.

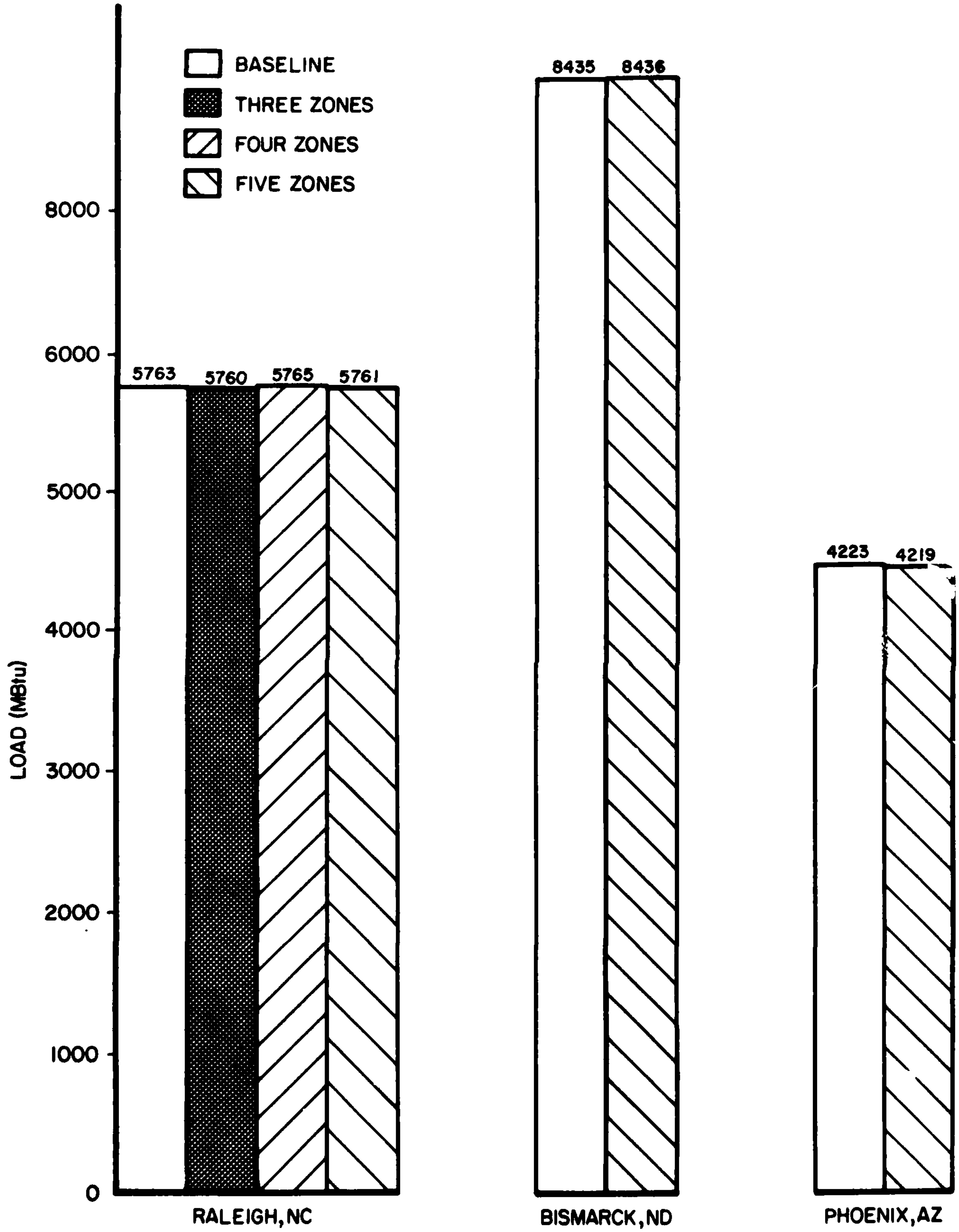

Figure 12. Total loads for the battalion headquarters and classroom building.

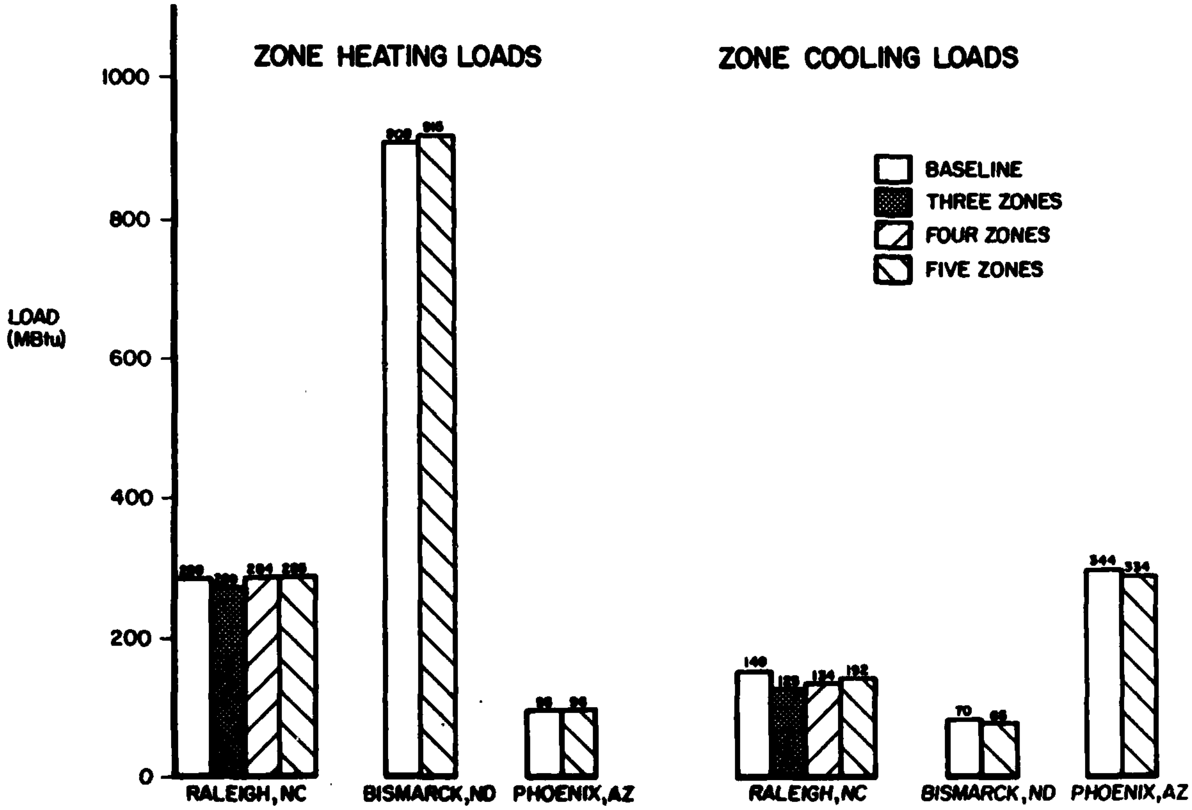

Figure 13. Zone load comparisons for the battalion headquarters and classroom building.

Table 5
The Effect of Mass on Loads
(Battalion Headquarters and Classroom Building, Raleigh, NC)

	Zone Loads (10^6 Btu) Heating		Zone Loads (10^6 Btu) Cooling		System Loads (10^6 Btu) Heating		System Loads (10^6 Btu) Cooling		Total Energy (10^6 Btu)	
	Sum	% Δ	Sum	% Δ	Sum	% Δ	Sum	% Δ	Sum	% Δ
Ten zones (detailed)										
Baseline	284	--	149	--	3924	--	1059	--	5763	--
No mass	352	24.5	196	31.5	4014	2.3	1092	3.1	5895	4.0
Five zones										
Baseline	285	--	142	--	3926	--	1056	--	5761	--
No mass	335	17.5	186	31.0	4000	1.9	1091	3.3	5879	2.0

Use of Simplified BLAST Input Model for Retrofit Analysis

A BLAST analysis of a similarly designed battalion headquarters and classroom building was performed for a Raleigh, NC, location using a detailed and simplified BLAST input model. Only the portion of the building served by the multizone system was modified. Table 6 lists each retrofit option studied. Table 7 and Figure 14 compare the simulation results of the detailed model with the simplified model for each retrofit option. As the results indicate, the energy savings resulting from each retrofit option compared with the baseline is similar when the simplified or detailed model is used. The simplified model always ranks the retrofit options in the same order as the detailed model.

Table 6
Description of Battalion Headquarters and Classroom Building Retrofit Options

Retrofit	Description
Baseline	Seven-zone multizone with single set-point thermostat set at 75°F. Outside air-controlled hot deck and fixed set-point cold deck at 58°F. 50% outside air.
R1	Same as above, except zone-controlled decks and no outside air.
R2	Change system to seven-zone variable air volume, with baseload heating and no outside air.

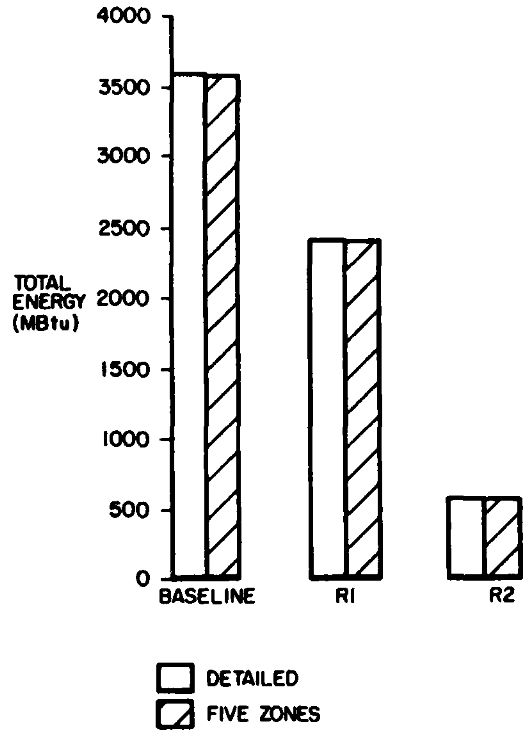

Figure 14. Retrofit option comparison for battalion headquarters and classroom building.

Table 7
Retrofit Option Simulation Results for Battalion Headquarters and Classroom Building

	Zone Loads (10^6 Btu) Heating		Cooling		System Loads (10^6 Btu) Heating		Cooling		Electricity		Total Energy (10^6 Btu)	
	Sum	% Δ Detail	Sum	% Δ Detail	Sum	% Δ Detail	Sum	% Δ Detail	Sum	% Δ Detail	Sum	% Δ Detail
Baseline												
Detailed	161	--	155	--	2069	--	1063	--	450	-	3582	
Five zones	160	-1	143	-8	2072	0	1057	-1	448	0	3577	0
R1												
Detailed	161	--	150	--	1628	--	351	--	447	--	2426	--
Five zones	160	-1	143	-5	1616	-1	345	-2	448	0	2409	-1
R2												
Detailed	73	--	116	--	115	--	98	--	335	--	548	
Five zones	72	-1	111	-4	114	-1	95	-3	334	0	543	-1

Summary

The battalion headquarters and classroom building can be accurately simulated by a five-zone simplified model. The five zones were chosen by first separating spaces with different types of fan systems. Each of these spaces was then subdivided into zones by separating perimeter (exposed to outside) areas, core areas, and the area which serves as buffer between the two (hall). In addition to minimizing the number of zones modeled, simplification included combining scheduled loads by type within each zone, combining windows of the same construction and facing the same direction, and describing all partitions as internal mass.

Discussion of Results

As with the simple BLAST input model developed for the rolling pin barracks, the simple BLAST input model used to simulate the battalion headquarters and classroom building can be generalized to other facilities. The results obtained by simplifying the BLAST input for the battalion headquarters and classroom building indicate some of the limits on the amount of simplification which can be generally applied:

1. If there are interior spaces which are physically separated from exterior spaces, these will have to be grouped as a separate zone.

2. Interior or exterior spaces which have widely varying use patterns (such as the hallway and conference rooms) must be grouped into separate zones.

3. Spaces on different *kinds* of heating and cooling systems or which are not heated and cooled to the same degree at the same time (such as the storage rooms) must be grouped separately.

Other generalizations include:

1. Spaces can be grouped into one zone even though they are not physically adjacent.

2. Building mass (in exterior and interior walls) is important, but interior partitions are not as long as mass is accounted for.

3. North- and south-facing spaces can be grouped if the south-facing walls have only a small amount of glass. (This verifies the results of the barracks study.)

Other Army facility types, particularly other administration facilities generally exhibit operating characteristics similar to the battalion headquarters and classroom building. Thus, similar simplified input models, with detail comparable to that discussed above, should be suitable for the energy analysis of these facilities.

5 DENTAL CLINIC: ANALYSIS AND FINDINGS

Building Description

A detailed description of the dental clinic was obtained from the as-built drawings and a field survey of a dental clinic located at Fort Hood, TX. Figure 15 shows the dental clinic floor plan, including the 10 heating, ventilating, and air-conditioning (HVAC) system zones of its air-handling system. Zone 11 in Figure 15 is the building's mechanical room, which is not air-conditioned. The building is a single-story, 18-chair dental clinic with laboratory. Its exterior walls are 4-in. face brick, 2-in. mortar, 4-in. concrete block, an air space, and 1/2-in. gypsum board. The exterior wall area is 4050 sq ft, of which about 340 sq ft are windows or glass doors. The floor is an 8-in. concrete slab with 1 in. of rigid insulation

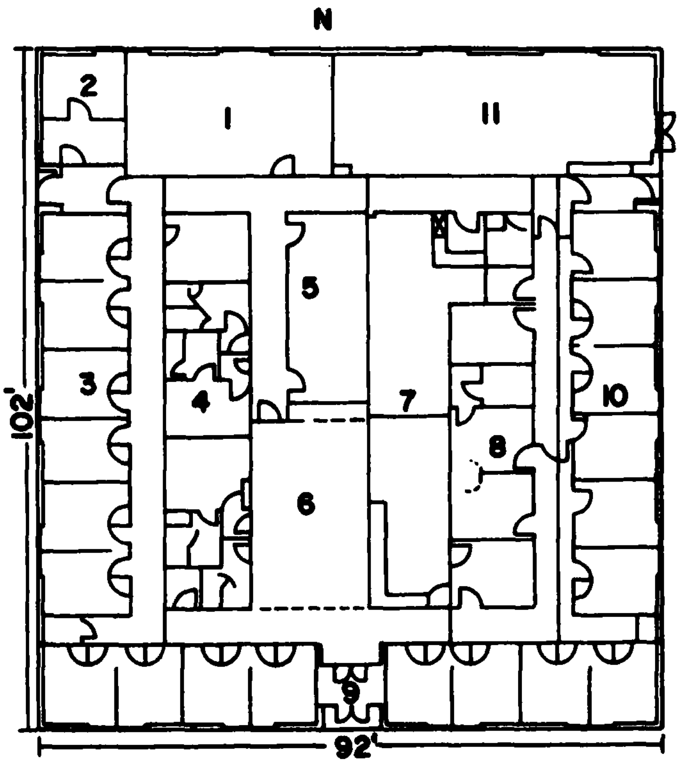

Figure 15. Dental clinic floor plan.

underneath and is situated over a crawlspace. The roof is a steel-truss built-up roof. The interior partitions are made of gypsum board. Construction details are shown in Figure 16. A reciprocating chiller and air-cooled condenser package supply the chilled water to the multizone system, and a gas-fired boiler is used for heating. The building occupancy, lighting load, electric equipment load, and gas equipment load were determined from the building survey.

Detailed BLAST Input Model

The clinic's detailed BLAST input model included 11 zones. Ten of these zones corresponded to the clinic's 10 HVAC system zones, and one zone corresponded to the crawlspace. The mechanical room was not included in the simulation. All exterior and interior walls, doors, and windows were input in their exact locations. Occupancy, lighting, and equipment levels were determined for each zone during the onsite survey. The BLAST input for the detailed dental clinic model is given in Appendix C.

The dental clinic's detailed BLAST input model was used to simulate the clinic's operation in three locations: Raleigh, NC; Bismarck, ND; and Phoenix, AZ. The simulation results are shown (as the baseline case) in Table 8 and Figures 17, 18, and 19. As the results indicate, the design and operation of the clinic's multizone air-conditioning system is such that the heating and cooling demands of the system are significantly higher than the heating and cooling energy demands of the building zones. For example, the system heating and cooling demands are factors of 20 and 2, respectively, higher than the zone heating and cooling requirements for the Raleigh, NC, data. This occurs because the multizone system heats and cools the zones simultaneously. During periods of small zone heating and cooling loads, the system mixes a hot and cold air stream to provide the space with essentially room temperature air. Thus, even when the zone demands for heating or cooling are small, the system heating and cooling demands are large. Because of this, changing zone demands for heating and cooling have little impact on the system energy demand. The results also show a very high building internal electric and gas equipment load. This provides zone heating and accounts for the small zone heating requirement.

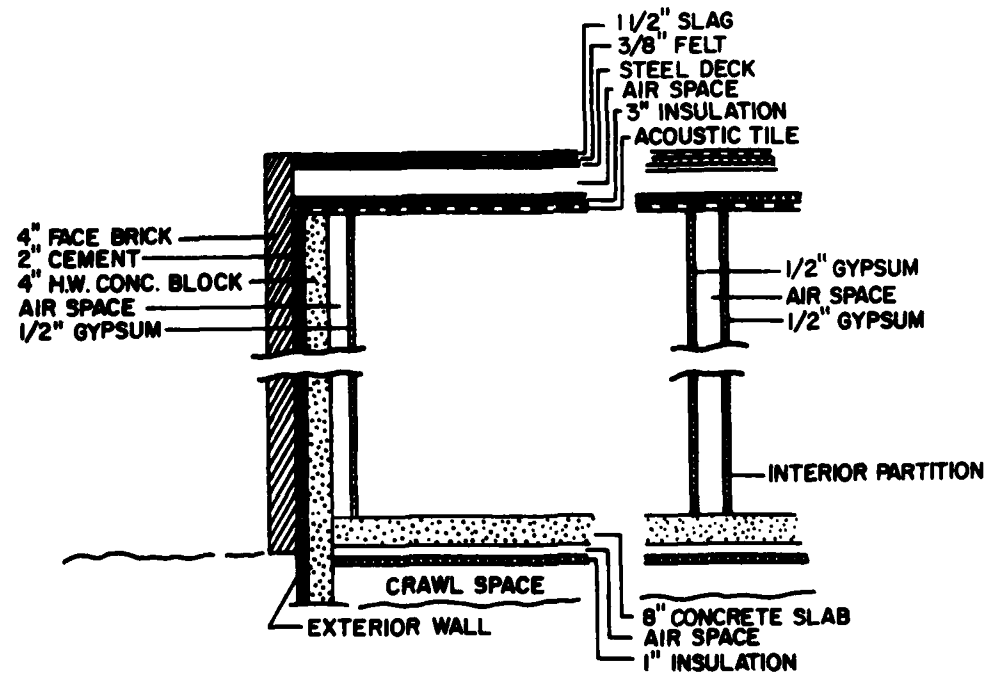

Figure 16. Dental clinic wall, floor, and ceiling details.

Table 8
Comparisons of Loads Calculated From Simplified Models With Loads Calculated From Baseline Model
(Dental Clinic)

	Zone Loads (10^6 Btu)				System Loads (10^6 Btu)				Building Equipment Loads (10^6 Btu)				Total Energy (10^6 Btu)	
	Heating		Cooling		Heating		Cooling		Gas		Electric			
	Sum	% Δ	Sum	% Δ	Sum	% Δ	Sum	% Δ	Sum	% Δ	Sum	% Δ	Sum	% Δ
Raleigh, NC														
B – Baseline with crawlspace	28	--	449	--	600	--	1077	--	22	--	496	--	2045	--
1a – One zone, no crawlspace, floor*	4	−86	463	3	584	−3	1141	6	22	0	496	0	2043	0
1b – One zone, no crawlspace, slab-on-grade**	10	−64	414	−8	606	1	1116	4	22	0	496	0	2056	1
2 – Two zones, no crawlspace, slab-on-grade	20	−29	427	−5	606	1	1088	1	22	0	496	0	2051	0
3 – Three zones, no crawlspace, slab-on-grade	20	−29	425	−5	605	1	1085	1	22	0	496	0	2050	0
4a – Four zones, no crawlspace, slab-on-grade	30	7	435	−3	606	1	1084	1	22	0	496	0	2050	0
4b – Four zones with crawlspace	27	−4	451	0	598	1	1091	1	22	0	496	0	2045	0
Bismarck, ND														
B – Baseline with crawlspace	160	--	303	--	1495	--	945	--	22	--	496	--	2915	--
4b – Four zones with crawlspace	157	−2	304	0	1495	0	945	0	22	0	496	0	2915	0
Phoenix, AZ														
B – Baseline with crawlspace	3	--	656	--	463	--	1567	--	22	--	496	--	2052	--
4b – Four zones with crawlspace	3	0	660	1	465	0	1572	0	20	0	496	0	2053	0

*Use of "floor" in BLAST does not allow heat transfer through the floor, but heat can be stored in the floor.
**Use of "slab-on-grade" in BLAST allows heat transfer from the building to the ground.

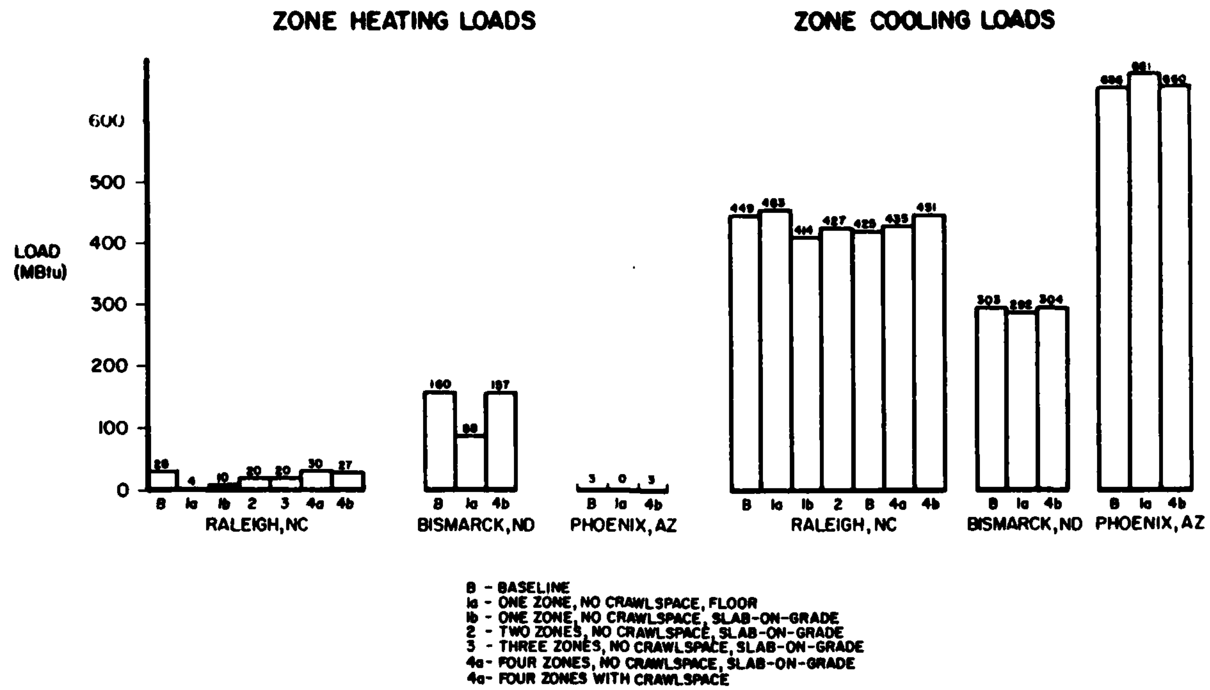

Figure 17. Zone loads, dental clinic.

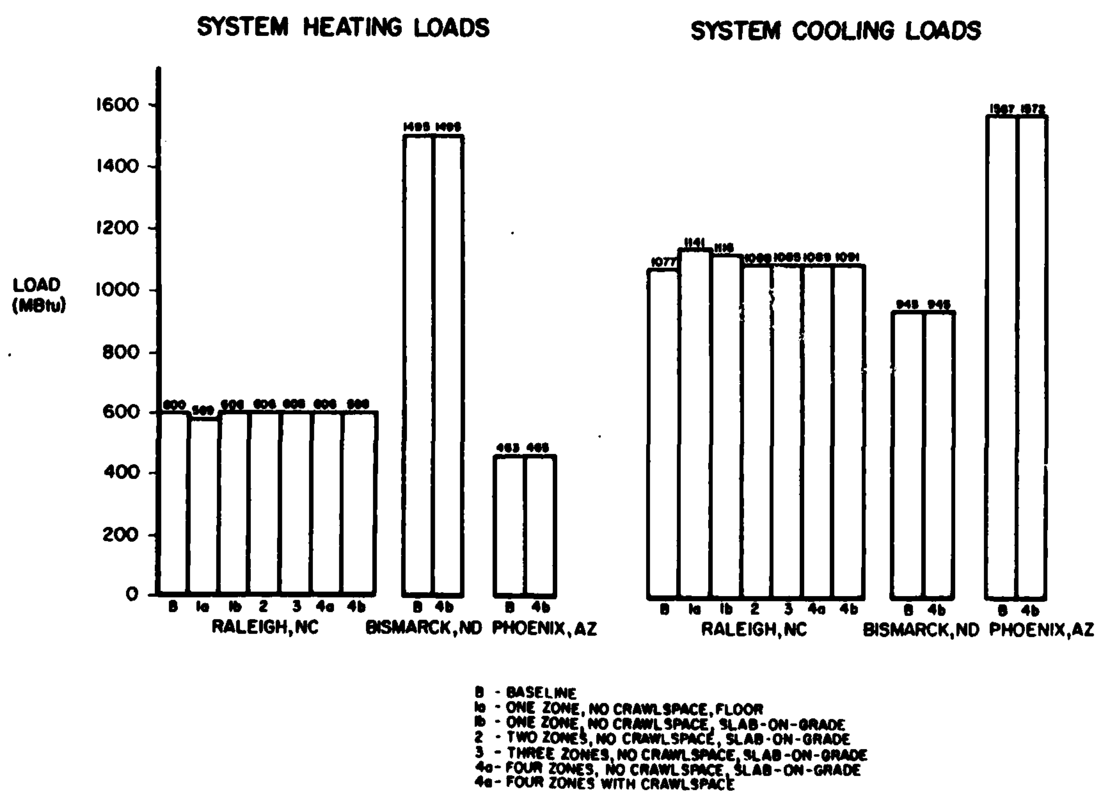

Figure 18. System loads, dental clinic.

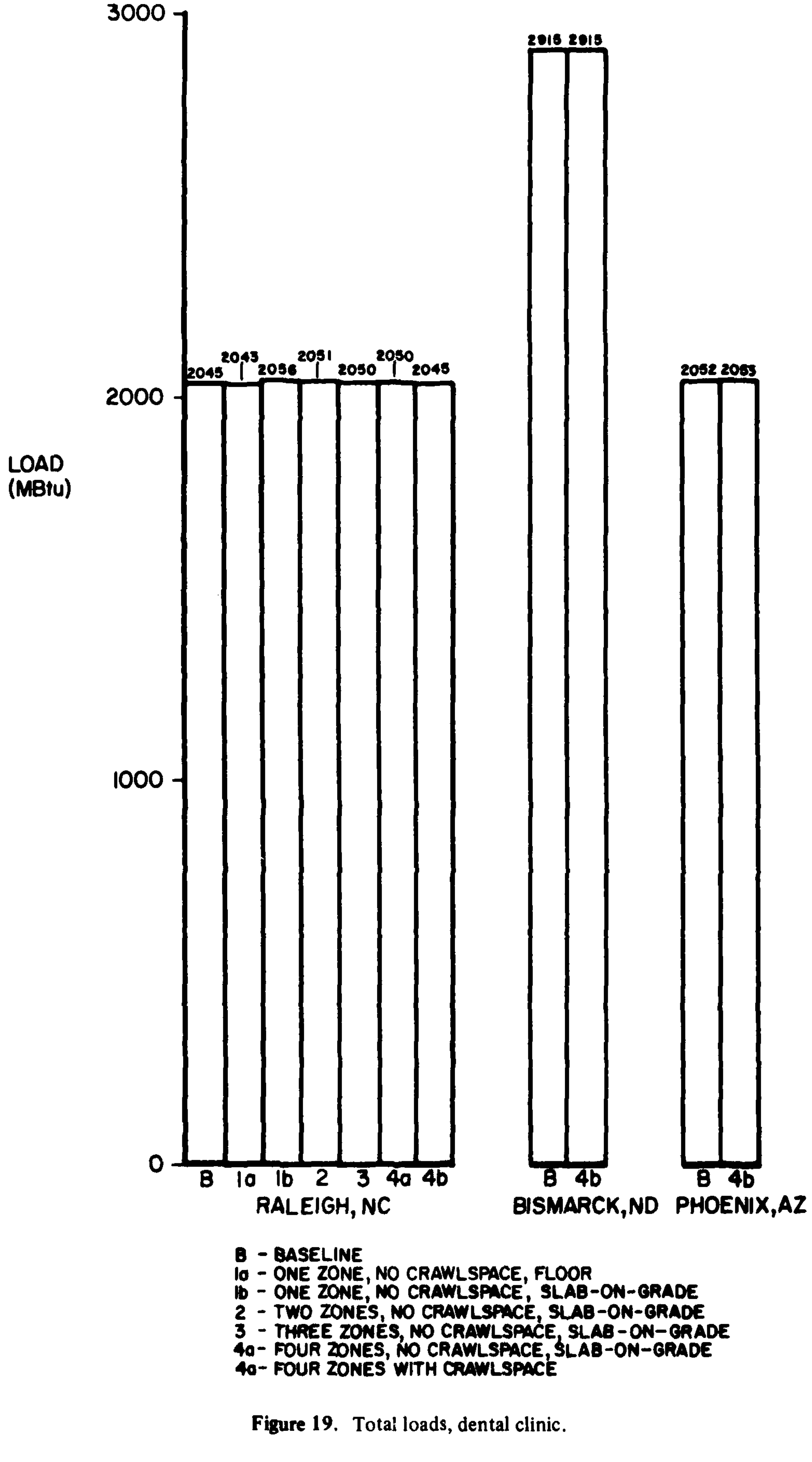

Figure 19. Total loads, dental clinic.

Simplified BLAST Input Model

For the simplified BLAST input model, the dental clinic was assumed to be a single zone with no crawlspace. The dental clinic floor was modeled as a floor between two conditioned spaces: no heat transfer was allowed through the floor, but heat could be stored within the concrete floor material. Exterior walls, windows, and doors were combined where possible. Wall coordinates were not used. Interior walls were input as internal mass. The building's occupancy, lighting, and internal equipment loads were the totals determined from the field survey. The fan system was modeled as a multizone system serving the one zone. The one-zone dental clinic model is shown in Appendix C.

This simplified model was used to simulate the dental clinic in Raleigh, NC. The results are shown (as case 1a) in Table 8 and Figures 17, 18, and 19. The zone cooling load and the system heating and cooling demands show good agreement with the baseline model. However, the zone heating load is 86 percent lower for the simple model than for the baseline. Thus, the simplified one-zone dental clinic model accurately predicts the total energy consumption of the building, but does not accurately predict the zone heating demands. As discussed earlier, the good agreement in total energy consumption is caused by decoupling system energy consumption from the zone heating and cooling requirements.

Improvements to the Simplified BLAST Input Model

Because the simplified one-zone model did not accurately predict the zone heating load, the model was revised. The floor was changed from a floor between conditioned spaces to a slab-on-grade floor. The slab-on-grade floor model allowed heat transfer from the building to the ground through the floor. This decreased the zone's cooling load and increased the zone's heating load. The revised one-zone model with the slab-on-grade floor was used to simulate the building in Raleigh, NC. The results are shown (as case 1b) in Table 8 and Figures 17, 18, and 19. Again, the model accurately predicted the building's total energy consumption, but, although improved over the previous model, underpredicted the zone heating load by 64 percent.

The one-zone model assumed that all the building's loads were evenly distributed. This is not a valid assumption for this building, since the sterilizer room (zone 8 in Figure 15) has a large internal equipment load (up to 30 kBtuh). When the entire building is modeled as one zone, the heat generated in zone 8 is assumed to be distributed evenly throughout the building. This reduces the heating requirements in some zones, since the internal equipment of zone 8 is used as a heat source. The cooling requirement of the sterilizer room is also reduced because the excess heat is distributed throughout the building, rather than being confined to one small area. Since this is not what actually occurs, the zone loads cannot be accurately calculated. This is shown by the zone heating and cooling loads, which are 64 and 8 percent lower, respectively, for case 1b than for the baseline.

A two-zone model of the dental clinic was created by putting the sterilizer room (zone 8 in Figure 15) into a separate zone (see Appendix C). The occupancy, lighting, and internal equipment loads for the sterilizer zone were as determined in the field survey and as used in the baseline model. The simulation results for this model for Raleigh, NC (case 2 in Table 8 and Figures 17, 18, and 19) show that the zone heating loads, although substantially improved, are still 29 percent lower than those for the baseline model.

A three-zone dental clinic model was developed which separated the building into a perimeter zone (zones 1, 2, 3, 9, and 10 in Figure 15), the sterilizer room zone (zone 8 in Figure 15), and a zone for the remaining interior space (zones 4, 5, 6, and 7 in Figure 15). This three-zone model, shown in Appendix C, should have accounted for the effect of the outside environment on the perimeter of the building and of the building equipment load on the interior, or core area, of the building. When used to simulate the clinic in Raleigh, NC, however, little improvement is seen in simulation accuracy compared with the two-zone model (case 3 in Table 8 and Figures 17, 18, and 19).

To further improve the accuracy of the simulation, a four-zone model was developed. The four-zone model was similar to the three-zone model except the perimeter zone of the three-zone model was divided into two zones. Because the lab areas (zones 1 and 2 in Figure 15) had large equipment loads compared with the rest of the perimeter area, the lab area was made into a separate zone. This model, shown in Appendix C, was used to simulate the building in Raleigh, NC. The results are shown as case 4a in Table 8 and Figures 17, 18, and 19. The zone heating load predicted by the four-zone model is 7 percent more than the baseline load. The zone cooling load, the system heating and cooling loads, and the total energy consumption agreed to better than 5 percent.

As a final step in revising the simplified dental clinic input simulation, a crawlspace zone was added to the four-zone model. This model, shown in Appendix C, was used to simulate the dental clinic in Raleigh, NC, Phoenix, AZ, and Bismarck, ND. The results of these simulations (case 4b in Table 8 and Figures 17, 18, and 19) show that the four-zone model with crawlspace accurately predicts the zone and system heating and cooling loads and the dental clinic's total energy consumption to within 4 percent of the baseline model's prediction.

Use of Simplified BLAST Input Model for Retrofit Analysis

A BLAST analysis of an all-electric dental clinic to identify an energy conservation retrofit option for a Raleigh, NC, location was performed using a detailed and a simplified BLAST input model. Table 9 describes each retrofit option. Table 10 and Figure 20 compare the simulation results of the detailed model with the simplified model for each retrofit option. As the results indicate, the energy savings resulting from each retrofit option compared with the baseline case is similar whether the simplified or the detailed model is used. Also, the simplified models always rank the retrofit options in the same order.

Summary

The dental clinic was accurately simulated by a four-zone plus crawlspace model. The four zones were chosen by dividing the building into an interior core area and a perimeter area, then subdividing each of these areas into two zones based on the amount of internal load within the space. The crawlspace had to be included to accurately model the heat transfer through the floor.

All simulation models of the dental clinic, including a very simple one-zone model, accurately predicted the building's total energy consumption. Only the four-zone model with crawlspace could be used, however, to predict accurate zone loads when compared with the baseline model. As discussed above, this occurs because the energy consumption of the clinic's multizone fan system is not directly related to the zone heating and cooling demands. Thus, designers interested only in the total energy consumption of the dental clinic with a multizone system could use a one-zone dental clinic model. Designers interested in the total energy consumption of the dental clinic with other fan system types which would more accurately track the zone heating and cooling requirements would have to use the more detailed four-zone model which accurately predicts zone loads. The four-zone model would also have to be used to analyze the effects of envelope or operational design changes on the building's energy consumption.

Table 9
Description of Retrofit Options for Dental Clinic

Retrofit	Description
Baseline	All-electric dental clinics with electric boiler. Ten-zone multizone with single set-point thermostat at 75°F. No night setback.
R1	Same as baseline, except system is shut off when building is unoccupied.
R2	Same as baseline, except there is a 10-zone variable air volume system with deadband thermostat which keeps clinic between 68 and 78°F constantly and constant supply air temperature of 55°F. Baseboard heaters provide heat.
R3	Same as R2, except system shuts off at night.
R4	Same as R3, except supply air temperature is zone-controlled.

Discussion of Results

The results of the dental clinic study confirmed many of the results found in the two previous studies:

1. Grouping individual rooms into single zones whether or not they are physically adjacent is acceptable.

2. Interior spaces must be separated from exterior spaces.

3. North- and south-facing spaces may be combined if the solar gain is not appreciable.

4. Interior walls and partitions can be ignored if their mass is accounted for.

In addition, some new generalizations can be drawn:

1. Spaces with high internal loads (like the sterilizer room and the lab space) must be treated as separate zones.

2. The effects of crawlspace or basements must be accounted for.

Table 10
Dental Clinic Retrofit Options

	Zone Loads (10^6 Btu)				System Loads (10^6 Btu)						Total Energy (10^6 Btu)	
	Heating		Cooling		Heating		Cooling		Electricity			
	Sum	% Δ detail	Sum	% Δ detail	Sum	% Δ detail	Sum	% Δ detail	Sum	% Δ detail	Sum	% Δ detail
R1												
Detailed	62	--	366	--	1272	--	1549	--	1565	--	2837	--
Four zones	61	−2	368	1	1283	1	1561	1	1569	1	2852	1
R2												
Detailed	16	--	259	--	412	--	594	--	885	--	1297	--
Four zones	15	6	260	0	386	−6	588	−2	872	1	1258	−3
R3												
Detailed	25	--	313	--	28	--	492	--	950	--	978	--
Four zones	24	4	313	0	26	7	524	7	961	1	987	1
R4												
Detailed	9	--	237	--	24	--	316	--	684	--	708	--
Four zones	9	0	238	0	24	0	318	1	684	0	708	0
R5												
Detailed	9	--	237	--	24	--	299	--	675	--	699	--
Four zones	9	0	238	0	24	0	301	1	675	0	699	0

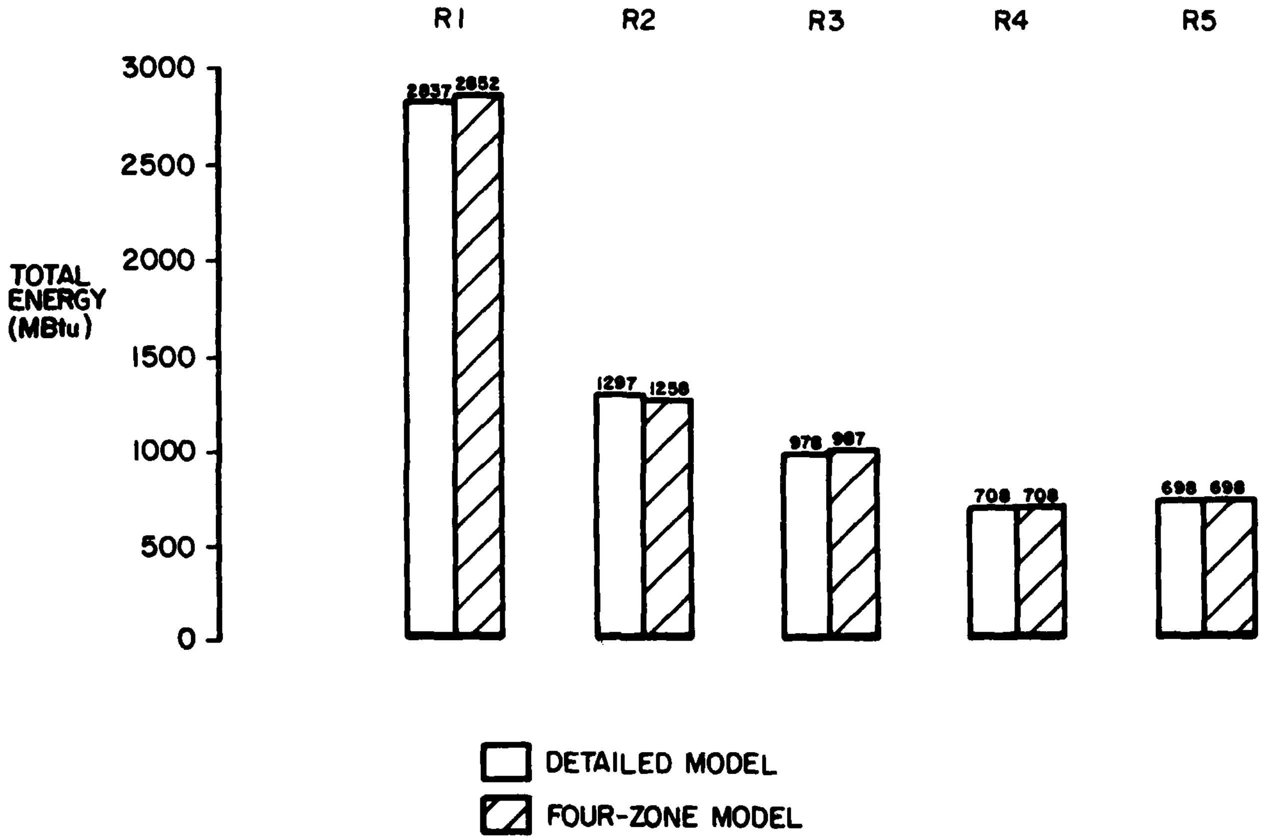

Figure 20. Total energy consumed for five retrofit options for the dental clinic.

6 CONCLUSIONS

The results of the BLAST simulations done for the three facility types considered during this study indicate:

1. Simplified BLAST input models predict annual energy consumption within ± 5 percent of the annual energy consumption predicted by the detailed models.

2. Simplified BLAST input models can be prepared more quickly than detailed BLAST models because they require substantially less input information, yet provide results as accurate as the detailed models.

3. Because simplified BLAST input models can accurately estimate a facility's energy consumption, BLAST can be used in the early stages of the MCA design process to evaluate design alternatives.

4. Simplified BLAST input models can be used to analyze the energy usage of retrofit options and design alternatives.

In addition, the following general guidelines for simplifying BLAST input were developed:

1. Multi-floor buildings do not have to have each floor modeled as a separate zone. Instead, the building can be modeled as one or more tall zones equal in height to the total building height.

2. Individual rooms can be grouped into one large zone if their use patterns and internal loads are similar. Grouped rooms do not have to be physically adjacent.

3. Interior spaces must be separated from exterior spaces.

4. Interior partitions can be ignored as long as their internal mass is accounted for.

5. The actual location of walls, windows, and doors are not needed unless some parts of the building shade themselves.

6. The actual shapes of walls, windows, and doors are immaterial as long as all the area and orientation are accounted for.

7. North- and south-facing spaces may be combined if the solar gain is not appreciable (i.e., if the south-facing walls have only a small amount of glass).

8. The effects of crawlspaces or basements must be accounted for.

APPENDIX A: BLAST INPUT MODELS FOR THE ROLLING PIN BARRACKS

```
**
**                  INPUT FILE = RPDI
**
**              RETROFIT OPTION = BASELINE
**
**
**    THIS IS A 18 ZONE BLAST 3.0 MODEL OF THE ROLLING PIN BARRACKS  (8/17/81)
**    THE BASELINE MODEL IS BASED ON DRAWING 21-01-39 FROM FT. BRAGG, NC.
**
**    THE AMOUNT OF INFILTRATION AND LIGHTING PER ZONE IS BASED ON
**    SQUARE FOOTAGE.
**
**    THE INFILTRATION COEFFICIENTS USED ARE NOT THE DEFAULT VALUES.
**    THEY ARE  A= 7.34E-1, B = 2.86E-3, C = 2.85E-4, D = 1.97E-8.
**
BEGIN INPUT;
   RUN CONTROL:  NEW ZONES, NEW AIR SYSTEMS,
 REPORTS(WALLS, ZONE, ZONE LOADS, SYSTEM, SYSTEM LOADS),
      UNITS(IN=ENGLISH,OUT=ENGLISH);
**
    DEFINE MATERIALS:
         CONC9 = (L =.75, K =.21, D =80., CP =.2, TABS =.9, ABS =.65,
                 MEDIUM ROUGH),
         STONE = (L =.5, K =.83, D =55., CP =.4, TABS =.9, ABS =.55,
                 ROUGH);
    END MATERIALS;
**
    DEFINE WALLS:
         XTW1 = (A7 - 4 IN FACE BRICK, B1 - AIRSPACE RESISTANCE,

                    C3 - 4 IN HW CONCRETE BLOCK),
         IW1 = (C3 - 4 IN HW CONCRETE BLOCK, B1 - AIRSPACE RESISTANCE,
                    C3 - 4 IN HW CONCRETE BLOCK),
         IW2 = (C3 - 4 IN HW CONCRETE BLOCK);
    END WALLS;
**
    DEFINE FLOORS:
         FLOOR1 = (DIRT 12 IN, STONE, AR2, C08),
         FLOOR2 = (CONC9);
    END FLOORS;
**
    DEFINE ROOFS:
         FLOOR2 = (CONC9),
         ROOF1 = (E2 - 1/2 IN SLAG OR STONE, E3 - 3/8 IN FELT AND MEMBRANE,
                 B6, C08);
    END ROOFS;
**
    DEFINE WINDOWS:
         WIND1 = (GLASS - CLEAR PLATE 1/4 IN);
    END WINDOWS;
**
    DEFINE SCHEDULE (OUTSIDE AIR):
         SUNDAY THRU SATURDAY = (00 TO 24-.262),
         HOLIDAY = SUNDAY;
```

```
     END SCHEDULE;
     DEFINE SCHEDULE (LAUN):
          MONDAY THRU FRIDAY = (00 TO 18-.0, 18 TO 22-1.0,
                                22 TO 24-.0),
          SATURDAY THRU SUNDAY = (00 TO 09-.0, 09 TO 17-1.0,

                                   17 TO 24-.0),
          HOLIDAY = SUNDAY;
     END;
     DEFINE SCHEDULE (DAYROOM):
          MONDAY THRU FRIDAY = (00 TO 08-.0, 08 TO 17-.05, 17 TO 24-.1),
          SATURDAY THRU SUNDAY = (00 TO 12-.0,12 TO 24-.1),
          HOLIDAY = SUNDAY;
     END;
  TEMPORARY SCHEDULE (VOLAR OCCUPANCY):
            SATURDAY = (22 TO 08 - 0.6, 08 TO 12 - 0.35,
                        12 TO 13 - 0.5, 13 TO 17 - 0.35,
                        17 TO 19 - 0.5, 19 TO 22 - 0.4),
            SUNDAY = SATURDAY,
            HOLIDAY = SATURDAY,
            MONDAY THRU FRIDAY = (22 TO 08 - 0.9, 08 TO 12 - 0.35,
                                  12 TO 13 - 0.5, 13 TO 17 - 0.35,
                                  17 TO 19 - 0.5, 19 TO 22 - 0.6);
  END;
 TEMPORARY SCHEDULE (VOLAR LIGHTING):
            SATURDAY = (00 TO 08 - .1, 08 TO 17 - .2,
                        17 TO 20 - .4, 20 TO 24 - .7),
            SUNDAY = SATURDAY,
            HOLIDAY = SATURDAY,
            MONDAY THRU FRIDAY = (00 TO 06 - .1, 06 TO 08 - .4,
                                  08 TO 18 - .25, 18 TO 21 - .5,
                                  21 TO 24 - .8);
 END;
 **
  TEMPORARY CONTROLS (HOODA)

    PROFILES:
         PROFILEA=(1.0 AT 68,0.0 AT 71, -0.0 AT 75, -1.0 AT 78);
    SCHEDULES:
          SUNDAY THRU SATURDAY = (00 TO 24 - PROFILEA),
          HOLIDAY = SUNDAY;
  END CONTROLS;
    PROJECT= "ROLLING PIN BARRACKS";
     WEATHER TAPE FROM 01JAN THRU 31DEC;
 **
 **                  GROUND TEMPERATURES FOR COLORADO SPRINGS (FT. COLLINS)
 **
     GROUND TEMPERATURE = (54,55,55,56,60,64,68,66,64,62,59,57);
 **
 BEGIN BUILDING DESCRIPTION; BUILDING = "ROLLING PIN BARRACKS";
          DIMENSIONS: N = 0, E = 90, S = 180, W = 270, F1 = 0, F2 = 10,
                      F3 = 20, H = 10, WH = 4.7, OVW = 2.5;
 **
 **    180 DEGREES IS THE STANDARD BUILDING ORIENTATION
 **
```

```
        NORTH AXIS = 180;
**
    ZONE 1 "LEFT WING, FIRST FLOOR, LOWER":
        ORIGIN: (0,6,F1);
        EXTERIOR WALLS :
            STARTING AT (0,0,0) FACING (S) XTW1 (57 BY H)
                WITH WINDOWS OF TYPE WIND1 (32 BY WH) AT (0,5)
                WITH OVERHANG (32 BY OVW) AT (0,H),
            STARTING AT (0,17,0) FACING (W) XTW1 (17 BY H)

                WITH WINDOWS OF TYPE WIND1 (8 BY WH) AT (0,5)
                WITH OVERHANG (8 BY OVW) AT (0,H);
        PARTITIONS:
            STARTING AT (0,17,0) FACING (S) IN2 (57 BY H),
            STARTING AT (57,0,0) FACING (E) IN1 (17 BY H);
        INTERNAL MASS: IN2 (161 BY H);
        SLAB ON GRADE FLOOR:
            STARTING AT (0,0,0) FACING (E) FLOOR1 (17 BY 57);
        CEILING:
            STARTING AT (0,0,H) FACING (S) FLOOR2 (57 BY 17);
        PEOPLE = 6, VOLAR OCCUPANCY;
        LIGHTS = 6, VOLAR LIGHTING;
        INFILTRATION = 135, CONSTANT,
            WITH COEFFICIENTS (.734, .00286, .000285, .0000000197);
        CONTROLS = HOODA, 38 HEATING, 24 COOLING;
    END ZONE;
**
    ZONE 2 "LEFT WING, SECOND FLOOR, LOWER":
        ORIGIN: (0,6,F2);
        SAME AS ZONE 1 EXCEPT:
            DELETE SLAB ON GRADE FLOOR;
            FLOOR:
                STARTING AT (0,0,0) FACING (E) FLOOR2 (17 BY 57);
            PEOPLE = 8, VOLAR OCCUPANCY;
            CONTROLS = HOODA, 38 HEATING, 26 COOLING;
    END ZONE;
**
    ZONE 3 "LEFT WING, THIRD FLOOR, LOWER":
        ORIGIN: (0,6,F3);
        SAME AS ZONE 2 EXCEPT:
            DELETE CEILING;
            ROOF:
                STARTING AT (0,0,H) FACING (S) ROOF1 (57 BY 17);
            CONTROLS = HOODA, 43 HEATING, 30 COOLING;
    END ZONE;
**
    ZONE 4 "LOWER CENTER, FIRST FLOOR":
        ORIGIN: (57,0,F1);
        EXTERIOR WALLS:
            STARTING AT (0,0,0) FACING (S) XTW1 (170 BY H)
                WITH WINDOWS OF TYPE WIND1 (72 BY WH) AT (0,5)
                WITH OVERHANG (72 BY OVW) AT (0,H),
            STARTING AT (170,0,0) FACING (E) XTW1 (6 BY H),
            STARTING AT (0,6,0) FACING (W) XTW1 (6 BY H);
```

```
          PARTITIONS:
               STARTING AT (170,6,0) FACING (E) IW1 (22.5 BY H),
               STARTING AT (170,28.5,0) FACING (N) IW2 (170 BY H),
               STARTING AT (0,28.5,0) FACING (W) IW1 (22.5 BY H);
          INTERNAL MASS: IW2 (570 BY H);
          SLAB ON GRADE FLOOR:
               STARTING AT (0,0,0) FACING (E) FLOOR1 (28.5 BY 170);
          CEILING:
               STARTING AT (0,0,H) FACING (S) FLOOR2 (170 BY 28.5);
          PEOPLE = 142, DAYROOM;
          LIGHTS = 29, DAYROOM;
          INFILTRATION = 673, CONSTANT,
               WITH COEFFICIENTS (.734, .00286, .000285, .0000000197);
          ELECTRIC EQUIPMENT = 20, LAUN;

          CONTROLS = HOODA, 124 HEATING, 78 COOLING;
     END ZONE;
**
     ZONE 5 "UPPER CENTER, FIRST FLOOR":
          ORIGIN: (57,28.5,F1);
          EXTERIOR WALLS:
               STARTING AT (170,11.5,0) FACING (E) XTW1 (17 BY H),
               STARTING AT (170,28.5,0) FACING (N) XTW1 (170 BY H)
                    WITH WINDOWS OF TYPE WIND1 (96 BY WH) AT (0,5)
                    WITH OVERHANG (96 BY OVW) AT (0,H),
               STARTING AT (0,28.5,0) FACING (W) XTW1 (17 BY H);
          PARTITIONS:
               STARTING AT (0,0,0) FACING (S) IW2 (170 BY H),
               STARTING AT (170,0,0) FACING (E) IW1 (11.5 BY H),
               STARTING AT (0,11.5,0) FACING (W) IW1 (11.5 BY H);
          INTERNAL MASS: IW2 (570 BY H);
          SLAB ON GRADE FLOOR:
               STARTING AT (0,0,0) FACING (E) FLOOR1 (28.5 BY 170);
          CEILING:
               STARTING AT (0,0,0) FACING (S) FLOOR2 (170 BY 28.5);
          PEOPLE = 24, VOLAR OCCUPANCY;
          LIGHTS = 29, VOLAR LIGHTING;
          INFILTRATION = 673, CONSTANT,
               WITH COEFFICIENTS (.734, .00286, .000285, .0000000197);
          CONTROLS = HOODA, 128 HEATING, 80 COOLING;
     END ZONE;
**
     ZONE 6 "LOWER CENTER, SECOND FLOOR":
          ORIGIN: (57,0,F2);
          SAME AS ZONE 4 EXCEPT:
               DELETE SLAB ON GRADE FLOOR;
               FLOOR:
                    STARTING AT (0,0,0) FACING (E) FLOOR2 (28.5 BY 170);
               DELETE INTERNAL MASS;
                    INTERNAL MASS: IW2 (770 BY H);
               PEOPLE = 18, VOLAR OCCUPANCY;
               LIGHTS = 29, VOLAR LIGHTING;
               ELECTRIC EQUIPMENT = 0, CONSTANT;
               CONTROLS = HOODA, 120 HEATING, 74 COOLING;
```

```
     END ZONE;
**
     ZONE 7 "UPPER CENTER, SECOND FLOOR":
          ORIGIN: (57,28.5,F2);
          SAME AS ZONE 5 EXCEPT:
               DELETE SLAB ON GRADE FLOOR;
               FLOOR:
                    STARTING AT (0,0,0) FACING (E) FLOOR2 (28.5 BY 170);
               DELETE INTERNAL MASS;
                    INTERNAL MASS: IW2 (520 BY H);
               PEOPLE = 32, VOLAR OCCUPANCY;
               CONTROLS = HOODA, 126 HEATING, 85 COOLING;
     END ZONE;
**
     ZONE 8 "LOWER CENTER, THIRD FLOOR":
          ORIGIN: (57,0,F3);
          SAME AS ZONE 6 EXCEPT:
               DELETE CEILING;
               ROOF:

                    STARTING AT (0,0,H) FACING (S) ROOF1 (170 BY 28.5);
               CONTROLS = HOODA, 148 HEATING, 97 COOLING;
     END ZONE;
**
     ZONE 9 "UPPER CENTER, THIRD FLOOR":
          ORIGIN: (57,28.5,F3);
          SAME AS ZONE 7 EXCEPT:
               DELETE CEILING;
               ROOF:
                    STARTING AT (0,0,H) FACING (S) ROOF1 (170 BY 28.5);
               CONTROLS = HOODA, 154 HEATING, 107 COOLING;
     END ZONE;
**
     ZONE 10 "RIGHT WING, FIRST FLOOR":
          ORIGIN: (284,6,F1);
          SAME AS ZONE 1 EXCEPT:
               MIRROR X;
     END ZONE;
**
     ZONE 11 "RIGHT WING, SECOND FLOOR":
          ORIGIN: (284,6,F2);
          SAME AS ZONE 2 EXCEPT:
               MIRROR X;
     END ZONE;
**
     ZONE 12 "RIGHT WING, THIRD FLOOR":
          ORIGIN: (284,6,F3);
          SAME AS ZONE 3 EXCEPT:
               MIRROR X;
     END ZONE;
**
     ZONE 13 "LEFT WING, FIRST FLOOR, UPPER":
          ORIGIN: (0,23,F1);
          EXTERIOR WALLS:
```

```
            STARTING AT (57,17,0) FACING (N) XTW1 (57 BY H)
                 WITH WINDOWS OF TYPE WIND1 (32 BY WH) AT (0,5)
                 WITH OVERHANG (32 BY OVW) AT (0,H),
            STARTING AT  (0,17,0) FACING (W) XTW1 (17 BY H);
       PARTITIONS:
            STARTING AT (0,0,0) FACING (S) IW2 (57 BY H),
            STARTING AT (57,0,0) FACING (E) IW1 (17 BY H);
       INTERNAL MASS: IW2 (161 BY H);
       SLAB ON GRADE FLOOR:
            STARTING AT (0,0,0) FACING (F) FLOOR1 (17 BY 57);
       CEILING:
            STARTING AT (0,0,0) FACING (S) FLOOR2 (57 BY 17);
       PEOPLE = 6, VOLAR OCCUPANCY;
       LIGHTS = 6, VOLAR LIGHTING;
       INFILTRATION = 135, CONSTANT,
            WITH COEFFICIENTS (.734, .00286, .000285, .0000000197);
       CONTROLS = HOODA, 36 HEATING, 23 COOLING;
  END ZONE;
**
  ZONE 14 "LEFT WING, SECOND FLOOR, UPPER":
       ORIGIN: (0,23,F2);
       SAME AS ZONE 13 EXCEPT:
            DELETE SLAB ON GRADE FLOOR;
            FLOOR:

                 STARTING AT (0,0,0) FACING (E) FLOOR2 (17 BY 57);
            CONTROLS = HOODA, 36 HEATING, 24 COOLING;
  END ZONE;
**
  ZONE 15 "LEFT WING, THIRD FLOOR, UPPER":
       ORIGIN: (0,23,F2);
       SAME AS ZONE 14 EXCEPT:
            DELETE CEILING;
            ROOF:
                 STARTING AT (0,0,H) FACING (S) ROOF1 (57 BY 17);
            CONTROLS = HOODA, 41 HEATING, 28 COOLING;
  END ZONE;
**
  ZONE 16 "RIGHT WING, FIRST FLOOR, UPPER":
       ORIGIN: (284,23,F1);
       SAME AS ZONE 13 EXCEPT:
            MIRROR X;
  END ZONE;
**
  ZONE 17 "RIGHT WING, SECOND FLOOR, UPPER":
       ORIGIN: (284,23,F2);
       SAME AS ZONE 14 EXCEPT:
            MIRROR X;
  END ZONE;
**
  ZONE 18 "RIGHT WING, THIRD FLOOR, UPPER":
       ORIGIN: (284,23,F3);
       SAME AS ZONE 15 EXCEPT:
            MIRROR X;
```

```
    END ZONE;
**
**
END BUILDING DESCRIPTION;
**
BEGIN FAN SYSTEM DESCRIPTION;
    TWO PIPE FAN COIL SYSTEM 1 "FAN COIL SYSTEM"
              SERVING ZONES 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18;
         FOR ZONE 1:
              SUPPLY AIR VOLUME = 755;
         END ZONE;
         FOR ZONE 2:
              SUPPLY AIR VOLUME = 795;
         END ZONE;
         FOR ZONE 3:
              SUPPLY AIR VOLUME = 925;
         END ZONE;
         FOR ZONE 4:
              SUPPLY AIR VOLUME = 2837;
         END ZONE;
         FOR ZONE 5:
              SUPPLY AIR VOLUME = 2837;
         END ZONE;
         FOR ZONE 6:
              SUPPLY AIR VOLUME = 2837;
         END ZONE;
         FOR ZONE 7:
              SUPPLY AIR VOLUME = 2837;
         END ZONE;

         FOR ZONE 8:
              SUPPLY AIR VOLUME = 3005;
         END ZONE;
         FOR ZONE 9:
              SUPPLY AIR VOLUME = 3330;
         END ZONE;
         FOR ZONE 10:
              SUPPLY AIR VOLUME = 755;
         END ZONE;
         FOR ZONE 11:
              SUPPLY AIR VOLUME = 795;
         END ZONE;
         FOR ZONE 12:
              SUPPLY AIR VOLUME = 925;
         END ZONE;
         FOR ZONE 13:
              SUPPLY AIR VOLUME = 725;
         END ZONE;
         FOR ZONE 14:
              SUPPLY AIR VOLUME = 745;
         END ZONE;
         FOR ZONE 15:
              SUPPLY AIR VOLUME = 875;
         END ZONE;
         FOR ZONE 16:
```

```
            SUPPLY AIR VOLUME = 725;
        END ZONE;
        FOR ZONE 17:
            SUPPLY AIR VOLUME = 745;

        END ZONE;
        FOR ZONE 18:
            SUPPLY AIR VOLUME = 875;
        END ZONE;
        OTHER SYSTEM PARAMETERS:
            SUPPLY FAN PRESSURE = 0.5;
            SUPPLY FAN EFFICIENCY = .45;
            COLD DECK TEMPERATURE = 45;
            COLD DECK CONTROL = FIXED SET POINT;
            HEATING COIL ENERGY SUPPLY = HOT WATER;
            HOT DECK TEMPERATURE = 140;
            HOT DECK CONTROL = FIXED SET POINT;
            HEATING COIL CAPACITY = 5000;
        END OTHER SYSTEM PARAMETERS;
        EQUIPMENT SCHEDULES:
            SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
**
**          FANCOIL EQUIPMENT SCHEDULES FOR COLORADO SPRINGS, CO
**
            FANCOIL COOLING OPERATION = OFF, FROM 17SEP THRU 20JUN;
            FANCOIL HEATING OPERATION = OFF, FROM 21JUN THRU 16SEP;
**
            MINIMUM VENTILATION SCHEDULE = OUTSIDE AIR, FROM 01JAN THRU 31DEC;
        END EQUIPMENT SCHEDULES;
    END SYSTEM;
END FAN SYSTEM DESCRIPTION;
END INPUT;
```

```
**
**                    INPUT FILE = RPSI
**
**               RETROFIT OPTION = BASELINE
**
**
**    THIS IS A 1 ZONE BLAST 3.0 MODEL OF THE ROLLING PIN BARRACKS  (8/17/81)
**    THE BASELINE MODEL IS BASED ON THE 18 ZONE BASELINE MODEL.
**
**    THE AMOUNT OF INFILTRATION AND LIGHTING PER ZONE IS BASED ON
**    SQUARE FOOTAGE.
**
**    THE INFILTRATION COEFFICIENTS USED ARE NOT THE DEFAULT VALUES.
**    THEY ARE  A= 7.34E-1, B = 2.86E-3, C = 2.85E-4, D = 1.97E-8.
**
BEGIN INPUT;
  RUN CONTROL:  NEW ZONES, NEW AIR SYSTEMS,
 REPORTS(WALLS, ZONE, ZONE LOADS, SYSTEM, SYSTEM LOADS),
     UNITS(IN=ENGLISH,OUT=ENGLISH);
**
   DEFINE MATERIALS:
        CONC9 = (L =.75, K =.21, D =80., CP =.2, TABS =.9, ABS =.65,
                MEDIUM ROUGH),
        STONE = (L =.5, K =.83, D =55., CP =.4, TABS =.9, ABS =.55,
                ROUGH);
   END MATERIALS;
**
   DEFINE WALLS:
        XTW1 = (A7 - 4 IN FACE BRICK, B1 - AIRSPACE RESISTANCE,

              C3 - 4 IN HW CONCRETE BLOCK),
        IW1 = (C3 - 4 IN HW CONCRETE BLOCK, B1 - AIRSPACE RESISTANCE,
              C3 - 4 IN HW CONCRETE BLOCK),
        IW2 = (C3 - 4 IN HW CONCRETE BLOCK),
        FLOOR2 = (CONC9);
   END WALLS;
**
   DEFINE FLOORS:
        FLOOR1 = (DIRT 12 IN, STONE, AR2, C08),
        FLOOR2 = (CONC9);
   END FLOORS;
**
   DEFINE ROOFS:
        FLOOR2 = (CONC9),
        ROOF1 = (E2 - 1/2 IN SLAG OR STONE, E3 - 3/8 IN FELT AND MEMBRANE,
                B6, C08);
   END ROOFS;
**
   DEFINE WINDOWS:
        WIND1 = (GLASS - CLEAR PLATE 1/4 IN);
   END WINDOWS;
**
   DEFINE SCHEDULE (OUTSIDE AIR):
        SUNDAY THRU SATURDAY = (00 TO 24-.262),
```

```
          HOLIDAY = SUNDAY;
     END SCHEDULE;
     DEFINE SCHEDULE (LAUN):
          MONDAY THRU FRIDAY = (00 TO 18-.0, 18 TO 22-1.0,
                                 22 TO 24-.0),

          SATURDAY THRU SUNDAY = (00 TO 09-.0, 09 TO 17-1.0,
                                   17 TO 24-.0),
          HOLIDAY = SUNDAY;
     END;
     DEFINE SCHEDULE (DAYROOM):
          MONDAY THRU FRIDAY = (00 TO 08-.0, 08 TO 17-.05, 17 TO 24-.1),
          SATURDAY THRU SUNDAY = (00 TO 12-.0,12 TO 24-.1),
          HOLIDAY = SUNDAY;
     END;
  TEMPORARY SCHEDULE (VOLAR OCCUPANCY):
            SATURDAY = (22 TO 08 - 0.6, 08 TO 12 - 0.35,
                        12 TO 13 - 0.5, 13 TO 17 - 0.35,
                        17 TO 19 - 0.5, 19 TO 22 - 0.4),
            SUNDAY = SATURDAY,
            HOLIDAY = SATURDAY,
            MONDAY THRU FRIDAY = (22 TO 08 - 0.9, 08 TO 12 - 0.35,
                                  12 TO 13 - 0.5, 13 TO 17 - 0.35,
                                  17 TO 19 - 0.5, 19 TO 22 - 0.6);
  END;
 TEMPORARY SCHEDULE (VOLAR LIGHTING):
           SATURDAY = (00 TO 08 - .1, 08 TO 17 - .2,
                       17 TO 20 - .4, 20 TO 24 - .7),
           SUNDAY = SATURDAY,
           HOLIDAY = SATURDAY,
           MONDAY THRU FRIDAY = (00 TO 06 - .1, 06 TO 08 - .4,
                                 08 TO 18 - .25, 18 TO 21 - .5,
                                 21 TO 24 - .8);
 END;
 **

  TEMPORARY CONTROLS (HOODA)
    PROFILES:
         PROFILEA=(1.0 AT 68,0.0 AT 71, -0.0 AT 75, -1.0 AT 78);
    SCHEDULES:
          SUNDAY THRU SATURDAY = (00 TO 24 - PROFILEA),
          HOLIDAY = SUNDAY;
  END CONTROLS;
     PROJECT= "ROLLING PIN BARRACKS";
     WEATHER TAPE FROM 01JAN THRU 31DEC;
 **
 **              GROUND TEMPERATURES FOR COLORADO SPRINGS (FT. COLLINS)
 **
     GROUND TEMPERATURE = (54,55,55,56,60,64,68,66,64,62,59,57);
 **
 BEGIN BUILDING DESCRIPTION; BUILDING = "ROLLING PIN BARRACKS";
          DIMENSIONS: N = 0, E = 90, S = 180, W = 270, F1 = 0, F2 = 10,
                      F3 = 20, H = 30, WH = 14.1, OVW = 7.5, OVH = 15.;
 **
          NORTH AXIS = 0;
```

```
**
          SOLAR DISTRIBUTION = -1;
     ZONE 1 "ENTIRE BUILDING":
          ORIGIN: (0,6,F1);
          EXTERIOR WALLS :
               FACING (N) XTW1 (284 BY H)
                    WITH WINDOWS OF TYPE WIND1 (136 BY WH) AT (0,0)
                    WITH OVERHANG (136 BY OVW) AT (0,OVH),
               FACING (E) XTW1 (57 BY H)

                    WITH WINDOWS OF TYPE WIND1 (8 BY WH) AT (0,0)
                    WITH OVERHANG (8 BY OVW) AT (0,OVH),
               FACING (S) XTW1 (284 BY H)
                    WITH WINDOWS OF TYPE WIND1 (160 BY WH) AT (0,0)
                    WITH OVERHANG (160 BY OVW) AT (0,OVH),
               FACING (W) XTW1 (57 BY H)
                    WITH WINDOWS OF TYPE WIND1 (8 BY WH) AT (0,0)
                    WITH OVERHANG (8 BY OVW) AT (0,OVH);
          INTERNAL MASS: IW1 (136 BY H);
          INTERNAL MASS: IW2 (1884 BY H);
          INTERNAL MASS: IW2 (568 BY H);
          INTERNAL MASS: FLOOR2 (57 BY 952);
          FLOOR:
               FACING (E) FLOOR1 (238 BY 57);
          ROOF:
               FACING (S) ROOF1 (57 BY 238);
          PEOPLE = 204, VOLAR OCCUPANCY;
          PEOPLE = 142, DAYROOM;
          LIGHTS = 217, VOLAR LIGHTING;
          LIGHTS = 29, DAYROOM;
          ELECTRIC EQUIPMENT = 20, LAUN;
          INFILTRATION = 5658, CONSTANT,
               WITH COEFFICIENTS (.734, .00286, .000285, .0000000197);
          CONTROLS = HOODA, 1264 HEATING, 831 COOLING;
     END ZONE;
**
END BUILDING DESCRIPTION;
**
BEGIN FAN SYSTEM DESCRIPTION;

     TWO PIPE FAN COIL SYSTEM 1 "FAN COIL SYSTEM"
              SERVING ZONES 1;
          FOR ZONE 1:
               SUPPLY AIR VOLUME = 27323;
          END ZONE;
          OTHER SYSTEM PARAMETERS:
               SUPPLY FAN PRESSURE = 0.5;
               SUPPLY FAN EFFICIENCY = .45;
               COLD DECK TEMPERATURE = 45;
               COLD DECK CONTROL = FIXED SET POINT;
               HEATING COIL ENERGY SUPPLY = HOT WATER;
               HOT DECK TEMPERATURE = 140;
               HOT DECK CONTROL = FIXED SET POINT;
               HEATING COIL CAPACITY = 5000;
          END OTHER SYSTEM PARAMETERS;
```

```
        EQUIPMENT SCHEDULES:
             SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
**
**           FANCOIL EQUIPMENT SCHEDULES FOR COLORADO SPRINGS, CO
**
             FANCOIL COOLING OPERATION = OFF, FROM 17SEP THRU 20JUN;
             FANCOIL HEATING OPERATION = OFF, FROM 21JUN THRU 16SEP;
**
             MINIMUM VENTILATION SCHEDULE = OUTSIDE AIR, FROM 01JAN THRU 31DEC;
        END EQUIPMENT SCHEDULES;
    END SYSTEM;
END FAN SYSTEM DESCRIPTION;
END INPUT;
```

```
**
**                     INPUT FILE = RPTI
**
**               RETROFIT OPTION = BASELINE
**
**
**     THIS IS A 2 ZONE BLAST 3.0 MODEL OF THE ROLLING PIN BARRACKS  (8/22/81)
**     THE BASELINE MODEL IS BASED ON THE 18 ZONE BASELINE MODEL.
**
**     THE AMOUNT OF INFILTRATION AND LIGHTING PER ZONE IS BASED ON
**     SQUARE FOOTAGE.
**
**     THE INFILTRATION COEFFICIENTS USED ARE NOT THE DEFAULT VALUES.
**     THEY ARE  A= 7.34E-1, B = 2.86E-3, C = 2.85E-4, D = 1.97E-8.
**
BEGIN INPUT;
   RUN CONTROL:  NEW ZONES, NEW AIR SYSTEMS,
 REPORTS(WALLS, ZONE, ZONE LOADS, SYSTEM, SYSTEM LOADS),
     UNITS(IN=ENGLISH,OUT=ENGLISH);
**
    DEFINE MATERIALS:
         CONC9 = (L =.75, K =.21, D =80., CP =.2, TABS =.9, ABS =.65,
                   MEDIUM ROUGH),
         STONE = (L =.5, K =.83, D =55., CP =.4, TABS =.9, ABS =.55,
                  ROUGH);
    END MATERIALS;
**
    DEFINE WALLS:
         XTW1 = (A7 - 4 IN FACE BRICK, B1 - AIRSPACE RESISTANCE,

                  C3 - 4 IN HW CONCRETE BLOCK),
         IW1 = (C3 - 4 IN HW CONCRETE BLOCK, B1 - AIRSPACE RESISTANCE,
                  C3 - 4 IN HW CONCRETE BLOCK),
         IW2 = (C3 - 4 IN HW CONCRETE BLOCK),
         FLOOR2 = (CONC9);
    END WALLS;
**
    DEFINE FLOORS:
         FLOOR1 = (DIRT 12 IN, STONE, AR2, C08),
         FLOOR2 = (CONC9);
    END FLOORS;
**
    DEFINE ROOFS:
         FLOOR2 = (CONC9),
         ROOF1 = (E2 - 1/2 IN SLAG OR STONE, E3 - 3/8 IN FELT AND MEMBRANE,
                   B6, C08);
    END ROOFS;
**
    DEFINE WINDOWS:
         WIND1 = (GLASS - CLEAR PLATE 1/4 IN);
    END WINDOWS;
**
    DEFINE SCHEDULE (OUTSIDE AIR):
         SUNDAY THRU SATURDAY = (00 TO 24-.262),
```

```
          HOLIDAY = SUNDAY;
     END SCHEDULE;
     DEFINE SCHEDULE (LAWN):
          MONDAY THRU FRIDAY = (00 TO 18-.0, 18 TO 22-1.0,
                                22 TO 24-.0),

          SATURDAY THRU SUNDAY = (00 TO 09-.0, 09 TO 17-1.0,
                                  17 TO 24-.0),
          HOLIDAY = SUNDAY;
     END;
     DEFINE SCHEDULE (DAYROOM):
          MONDAY THRU FRIDAY = (00 TO 08-.0, 08 TO 17-.05, 17 TO 24-.1),
          SATURDAY THRU SUNDAY = (00 TO 12-.0,12 TO 24-.1),
          HOLIDAY = SUNDAY;
     END;
 TEMPORARY SCHEDULE (VOLAR OCCUPANCY):
            SATURDAY = (22 TO 08 - 0.6, 08 TO 12 - 0.35,
                        12 TO 13 - 0.5, 13 TO 17 - 0.35,
                        17 TO 19 - 0.5, 19 TO 22 - 0.4),
            SUNDAY = SATURDAY,
            HOLIDAY = SATURDAY,
            MONDAY THRU FRIDAY = (22 TO 08 - 0.9, 08 TO 12 - 0.35,
                                  12 TO 13 - 0.5, 13 TO 17 - 0.35,
                                  17 TO 19 - 0.5, 19 TO 22 - 0.6);
 END;
TEMPORARY SCHEDULE (VOLAR LIGHTING):
          SATURDAY = (00 TO 08 - .1, 08 TO 17 - .2,
                      17 TO 20 - .4, 20 TO 24 - .7),
          SUNDAY = SATURDAY,
          HOLIDAY = SATURDAY,
          MONDAY THRU FRIDAY = (00 TO 06 - .1, 06 TO 08 - .4,
                                08 TO 18 - .25, 18 TO 21 - .5,
                                21 TO 24 - .8);
END;
**

 TEMPORARY CONTROLS (HOUDA)
   PROFILES:
       PROFILEA=(1.0 AT 68,0.0 AT 71, -0.0 AT 75, -1.0 AT 78);
   SCHEDULES:
         SUNDAY THRU SATURDAY = (00 TO 24 - PROFILEA),
         HOLIDAY = SUNDAY;
 END CONTROLS;
    PROJECT= "ROLLING PIN BARRACKS";
    WEATHER TAPE FROM 01JAN THRU 31DEC;
**
**             GROUND TEMPERATURES FOR COLORADO SPRINGS (FT. COLLINS)
**
    GROUND TEMPERATURE = (54,55,55,56,60,64,68,66,64,62,59,57);
**
BEGIN BUILDING DESCRIPTION; BUILDING = "ROLLING PIN BARRACKS";
         DIMENSIONS: N = 0, E = 90, S = 180, W = 270, F1 = 0, F2 = 10,
                     F3 = 20, H = 30, WH = 14.1, OVW = 7.5, OVH = 15.;
**
**    180 DEGREES IS THE STANDARD BUILDING ORIENTATION
```

```
**
        NORTH AXIS = 0;
**
        SOLAR DISTRIBUTION = -1;
    ZONE 1 "NORTH BUILDING":
        ORIGIN: (0,6,F1);
        EXTERIOR WALLS :
             FACING (N) XTW1 (284 BY H)
                  WITH WINDOWS OF TYPE WIND1 (136 BY WH) AT (0,0)
                  WITH OVERHANG (136 BY OVW) AT (0,OVH),
             FACING (F) XTW1 (23 BY H)
                  WITH WINDOWS OF TYPE WIND1 (8 BY WH) AT (0,0)
                  WITH OVERHANG (8 BY OVW) AT (0,OVH),
             FACING (W) XTW1 (23 BY H)
                  WITH WINDOWS OF TYPE WIND1 (8 BY WH) AT (0,0)
                  WITH OVERHANG (8 BY OVW) AT (0,OVH);
        INTERNAL MASS: IW1 (79 BY H);
        INTERNAL MASS: IW2 (1309.33 BY H);
        FLOOR:
                FACING (E) FLOOR2 (238 BY 57);
        CEILING:
             FACING (S) FLOOR2 (238 BY 57);
        SLAB ON GRADE FLOOR:
             FACING (E) FLOOR1 (119 BY 57);
        ROOF:
             FACING (S) ROOF1 (57 BY 119);
        PEOPLE = 80, VOLAR OCCUPANCY;
        PEOPLE = 142, DAYROOM;
        LIGHTS = 94, VOLAR LIGHTING;
        LIGHTS = 29, DAYROOM;
        ELECTRIC EQUIPMENT = 20, LAUN;
        INFILTRATION = 2829, CONSTANT,
             WITH COEFFICIENTS (.734, .00286, .000285, .0000000197);
        CONTROLS = HONDA, 630 HEATING, 409 COOLING;
    END ZONE;
**
    ZONE 2 "SOUTH SIDE":
        ORIGIN: (0,0,0);

        EXTERIOR WALLS:
             FACING (S) XTW1 (284 BY H)
                  WITH WINDOWS OF TYPE WIND1 (160 BY WH) AT (0,0)
                  WITH OVERHANG (160 BY OVW) AT (0,OVH),
             FACING (E) XTW1 (34 BY H),
             FACING (W) XTW1 (34 BY H);
        INTERNAL MASS: IW1 (57 BY H);
        INTERNAL MASS: IW2 (1142.67 BY H);
        FLOOR:
             FACING (E) FLOOR2 (238 BY 57);
        CEILING:
             FACING (S) FLOOR2 (238 BY 57);
        SLAB ON GRADE FLOOR:
             FACING (E) FLOOR1 (119 BY 57);
        ROOF:
```

```
          FACING (S) ROOF1 (57 BY 119);
       PEOPLE = 124, VOLAR OCCUPANCY;
       LIGHTS = 123, VOLAR LIGHTING;
       INFILTRATION = 2829, CONSTANT,
            WITH COEFFICIENTS (.734, .00286, .000285, .0000000197);
       CONTROLS = HUNDA, 634 HEATING, 422 COOLING;
    END ZONE;
**
END BUILDING DESCRIPTION;
**
BEGIN FAN SYSTEM DESCRIPTION;
    TWO PIPE FAN COIL SYSTEM 1 "FAN COIL SYSTEM"
            SERVING ZONES 1,2;
       FOR ZONE 1:
            SUPPLY AIR VOLUME = 13629;
       END ZONE;
       FOR ZONE 2:
            SUPPLY AIR VOLUME = 13694;
       END ZONE;
       OTHER SYSTEM PARAMETERS:
            SUPPLY FAN PRESSURE = 0.5;
            SUPPLY FAN EFFICIENCY = .45;
            COLD DECK TEMPERATURE = 45;
            COLD DECK CONTROL = FIXED SET POINT;
            HEATING COIL ENERGY SUPPLY = HOT WATER;
            HOT DECK TEMPERATURE = 140;
            HOT DECK CONTROL = FIXED SET POINT;
            HEATING COIL CAPACITY = 5000;
       END OTHER SYSTEM PARAMETERS;
       EQUIPMENT SCHEDULES:
            SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
**
**          FANCOIL EQUIPMENT SCHEDULES FOR COLORADO SPRINGS, CO
**
            FANCOIL COOLING OPERATION = OFF, FROM 17SEP THRU 20JUN;
            FANCOIL HEATING OPERATION = OFF, FROM 21JUN THRU 16SEP;
**
            MINIMUM VENTILATION SCHEDULE = OUTSIDE AIR, FROM 01JAN THRU 31DEC;
       END EQUIPMENT SCHEDULES;
    END SYSTEM;
END FAN SYSTEM DESCRIPTION;
END INPUT;
```

APPENDIX B: BLAST INPUT MODELS FOR THE BATTALION HEADQUARTERS AND CLASSROOM BUILDING

```
C
**                    INPUT FILE = ADMINP
**
**       THIS IS A BASELINE MODEL OF AN ADMIN BUILDING
**
**
  BEGIN INPUT;
   RUN CONTROL : NEW ZONES, NEW SYSTEMS, PLANT,
      UNITS(IN=ENGLISH,OUT=ENGLISH),
REPORTS (ZONE LOADS,SYSTEM LOADS,COIL LOADS,SYSTEM,PLANT LOADS,
WALLS,ZONE);
DEFINE LOCATION:
   FT CARSON = (LAT=38.75,LONG=104.5,TZ=7);
END;
DEFINE DESIGN DAYS:
      FT CARSON SUMMER = (HIGH=92,LOW=61,WB=59,DATE=21JUL,WEEKDAY,P
      FT CARSON WINTER = (HIGH=10,LOW=-2,WB=-2,DATE=21JAN,WEEKEND,P
END;
TEMPORARY WALLS:
   WALL = (BRICK - FACE 4 IN,
           AIRSPACE - VERTICAL,
           C8 - 8 IN HW CONCRETE BLOCK);
   WALL1= (E1 - 3/4 IN PLASTER OR GYP BOARD,
           AIRSPACE - VERTICAL,
           E1 - 3/4 IN PLASTER OR GYP BOARD),
   WALL2= (C8 - 8 IN HW CONCRETE BLOCK);
END;
TEMPORARY ROOFS:
   ROOF    = (E2 - 1 / 2 IN SLAG OR STONE,

           E3 - 3 / 8 IN FELT AND MEMBRANE,
           B6 - 2 IN DENSE INSULATION,
           A3 - STEEL SIDING,
           B6 - 2 IN DENSE INSULATION,
           E4 - CEILING AIRSPACE,
           E5 - ACOUSTIC TILE);
END;
TEMPORARY CONTROLS (ADMIN COOL AND HEAT):
   PROFILES:
       CANDH = (1 AT 74, 0 AT 76., -1 AT 78);
   SCHEDULES:
       MONDAY THRU SUNDAY = (00 TO 24 - CANDH),
       HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (ADMIN H ONLY):
   PROFILES:
     HONLY = (1 AT 74, 0 AT 76);
   SCHEDULES:
      MONDAY THRU SUNDAY = (00 TO 24 - HONLY),
      HOLIDAY = SUNDAY;
END;
 TEMPORARY SCHEDULE (ADMIN OFFICE OCCUPANCY):
     SATURDAY THRU SUNDAY = (00 TO 24 - .2),
     MONDAY THRU FRIDAY = (17 TO 06 - .2,06 TO 08 - .5,08 TO 12
```

```
                         12 TO 13 - .67,13 TO 17 - 1.);
 END;
 TEMPORARY SCHEDULE (ADMIN CLASSROOM OCCUPANCY):
     SATURDAY THRU SUNDAY = (00 TO 24 - 0.),

     MONDAY THRU FRIDAY = (11 TO 09 - 0.,09 TO 11 - 1.);
 END;
TEMPORARY SCHEDULE (OA VENT):
      SUNDAY THRU SATURDAY = (00 TO 24 - .5);
END;
 TEMPORARY SCHEDULE (OFF):
    SUNDAY THRU SATURDAY = (00 TO 24 - 0.);
 END;
TEMPORARY SCHEDULE (ADMIN LIGHTS):
 MONDAY THRU FRIDAY = (20 TO 07 - .49,.63,08 TO 18 - 1.,.82,.63),
 SATURDAY THRU SUNDAY = (00 TO 24 - .49),
   HOLIDAY = SUNDAY;
END;
PROJECT = "ADMIN BUILDING";
**       GROUND TEMPERATURES FOR RALEIGH,NC (CALHOUN,SC)
**
 GROUND TEMPERATURE = (64,65,65,66,69,72,75,74,74,73,70,67);
**
**
**
**
**
WEATHER TAPE FROM 01JAN THRU 31DEC;
  BEGIN BUILDING DESCRIPTION;
      NORTH AXIS=0.;
    DIMENSIONS: H1=10.75;
ZONE 101 "STORAGE A":

   ORIGIN:(0,0,0);
   NORTH AXIS = 0;
   ROOF:
      STARTING AT (0,0,H1) FACING (180) ROOF (41 BY 77);
   SLAB ON GRADE FLOOR:
      STARTING AT (0,77,0) FACING (180) FLOOR SLAB 4 IN (41 BY 77);
   EXTERIOR WALLS:
      STARTING AT (0,0,0) FACING (180) WALL (41 BY H1),
      STARTING AT (41,77,0) FACING (0) WALL (41 BY H1),
      STARTING AT (0,77,0) FACING (270) WALL (77 BY H1);
   PARTITIONS:
      STARTING AT (41,0,0) FACING (90) WALL1 (77 BY H1);
LIGHTS = 16.59,ADMIN LIGHTS;
PEOPLE = 7,ADMIN OFFICE OCCUPANCY;
CONTROLS = ADMIN H ONLY,53 HEATING;
END ZONE;
ZONE 4 "OFFICE A":
   ORIGIN:(41,0,0);
   NORTH AXIS = 0.;
   ROOF:
      STARTING AT (0,0,H1) FACING (180) ROOF(17 BY 10),
      STARTING AT (17,0,H1) FACING (180) ROOF (13 BY 19),
```

```
      STARTING AT (30,0,H1) FACING (180) ROOF (28 BY 28);
   SLAB ON GRADE FLOOR:
      STARTING AT (0,10,0) FACING (180) FLOOR SLAB 4 IN (17 BY 10),
      STARTING AT (17,19,0) FACING (180) FLOOR SLAB 4 IN (13 BY 19),
      STARTING AT (30,28,0) FACING (180) FLOOR SLAB 4 IN (28 BY 28);
   EXTERIOR WALLS:
      STARTING AT (0,0,0) FACING (180) WALL (58 BY H1)

         WITH WINDOWS OF TYPE SINGLE PANE WITH BLINDS
         (5.33 BY H1) AT (5,0) AND (26,0) AND (51,0),
      STARTING AT (58,0,0) FACING (90) WALL (20 BY H1);
   PARTITIONS:
      STARTING AT (58,20,0) FACING (90) WALL (8 BY H1),
      STARTING AT (58,28,0) FACING (0)  WALL1 (28 BY H1),
      STARTING AT (30,28,0) FACING (270) WALL1 (9 BY H1),
      STARTING AT (30,19,0) FACING (0) WALL1 (13 BY H1),
      STARTING AT (17,19,0) FACING (270) WALL1 (9 BY H1),
      STARTING AT (17,10,0) FACING (0) WALL1 (17 BY H1),
      STARTING AT (0,10,0) FACING (270) WALL1 (10 BY H1);
   LIGHTS = 6.26,ADMIN LIGHTS;
   CONTROLS = ADMIN COOL AND HEAT,33 HEATING,25 COOLING;
PEOPLE = 4,ADMIN OFFICE OCCUPANCY;
END ZONE;
ZONE 3 "CONFERENCE A":
   ORIGIN:(41,10,0);
   NORTH AXIS=0;
   ROOF:
      STARTING AT (0,0,H1) FACING (180) ROOF (17 BY 9),
      STARTING AT (0,9,H1) FACING (180) ROOF (30 BY 14);
   SLAB ON GRADE FLOOR:
      STARTING AT (0,9,0) FACING (180) FLOOR SLAB 4 IN (17 BY 9),
      STARTING AT (0,23,0) FACING (180) FLOOR SLAB 4 IN (30 BY 14);
   PARTITIONS:
      STARTING AT (0,0,0) FACING (180) WALL1 (17 BY H1),
      STARTING AT (17,0,0) FACING (90) WALL1 (9 BY H1),
      STARTING AT (17,9,0) FACING (180) WALL1 (13 BY H1),
      STARTING AT (30,9,0) FACING (90) WALL1 (14 BY H1),
      STARTING AT (30,23,0) FACING (0) WALL1 (30 BY H1),
      STARTING AT (0,23,0) FACING (270) WALL1 (23 BY H1);
      LIGHTS = 2.79,ADMIN LIGHTS;
      CONTROLS = ADMIN COOL AND HEAT,3 HEATING,5 COOLING;
PEOPLE = 2,ADMIN OFFICE OCCUPANCY;
END ZONE;
ZONE 1 "CLASSROOM A":
   ORIGIN: (41,40,0);
   NORTH AXIS = 0;
   ROOF:
      STARTING AT (0,0,H1) FACING (180) ROOF (70 BY 37);
   SLAB ON GRADE FLOOR:
      STARTING AT (0,37,0) FACING (180) FLOOR SLAB 4 IN (70 BY 37);
   PARTITIONS:
      STARTING AT (0,0,0) FACING (180) WALL2 (70 BY H1),
      STARTING AT (70,0,0) FACING (90) WALL2 (16 BY H1),
      STARTING AT (0,37,0) FACING (270) WALL1 (37 BY H1);
```

```
   EXTERIOR WALLS:
      STARTING AT (70,37,0) FACING (0) WALL (70 BY H1);
   WALLS TO UNCOOLED SPACES:
      STARTING AT (70,16,0) FACING (90) WALL2 (21 BY H1);
   LIGHTS = 13.54,ADMIN LIGHTS;
   CONTROLS = ADMIN COOL AND HEAT,40 HEATING,28 COOLING;
PEOPLE = 25,ADMIN CLASSROOM OCCUPANCY;
END ZONE;
ZONE 2 "HALLWAY":
   ORIGIN:(41,33,0);
   NORTH AXIS = 0;
   ROOF:

      STARTING AT (70,7,H1) FACING (180) ROOF (38 BY 18),
      STARTING AT (0,0,H1) FACING(180) ROOF (30 BY 7),
      STARTING AT (30,-5,H1) FACING (180) ROOF (28 BY 12),
      STARTING AT (58,-13,H1) FACING (180) ROOF (62 BY 20),
      STARTING AT (120,-5,H1) FACING (180) ROOF (28 BY 12),
      STARTING AT (148,0,H1) FACING (180) ROOF (30 BY 7);
   SLAB ON GRADE FLOOR:
      STARTING AT (70,25,0) FACING (180) FLOOR SLAB 4 IN (38 BY 18),
      STARTING AT (0,7,0) FACING (180) FLOOR SLAB 4 IN (30 BY 7),
      STARTING AT (30,7,0) FACING (180) FLOOR SLAB 4 IN (28 BY 12),
      STARTING AT (58,7,0) FACING (180) FLOOR SLAB 4 IN (62 BY 20),
      STARTING AT (120,7,0) FACING (180) FLOOR SLAB 4 IN (28 BY 12),
      STARTING AT (148,7,0) FACING (180) FLOOR SLAB 4 IN (30 BY 7);
   EXTERIOR WALLS:
      STARTING AT (58,-13,0) FACING (180) WALL (62 BY H1);
   WALLS TO UNCOOLED SPACE:
      STARTING AT (108,25,0) FACING (0) WALL2 (38 BY H1);
  CONTROLS = ADMIN COOL AND HEAT,53 HEATING,19 COOLING;
PEOPLE = 1,ADMIN OFFICE OCCUPANCY;
END ZONE;
ZONE 5 "OFFICE B":
   ORIGIN:(161,0,0);
   NORTH AXIS=0;
   ROOF:
      STARTING AT (0,0,H1) FACING (180) ROOF (28 BY 28),
      STARTING AT (28,0,H1) FACING (180) ROOF (13 BY 19),
      STARTING AT (41,0,H1) FACING (180) ROOF (17 BY 10);
   FLOOR:
      STARTING AT (0,28,0) FACING (180) FLOOR39 (28 BY 28),

      STARTING AT (28,19,0) FACING (180) FLOOR39 (13 BY 19),
      STARTING AT (41,10,0) FACING (180) FLOOR39 (17 BY 10);
   EXTERIOR WALLS:
      STARTING AT (0,0,0) FACING (180) WALL (58 BY H1)
         WITH WINDOWS OF TYPE SINGLE PANE WITH BLINDS
         (5.33 BY H1) AT (1.67,0) AND (17,0) AND (48,0),
      STARTING AT (0,20,0) FACING (270) WALL (20 BY H1);
   PARTITIONS:
      STARTING AT (58,0,0) FACING (90) WALL1 (10 BY H1),
      STARTING AT (58,10,0) FACING (0) WALL1 (17 BY H1),
      STARTING AT (41,10,0) FACING (90) WALL1 (9 BY H1),
      STARTING AT (41,19,0) FACING (0) WALL1 (13 BY H1),
```

```
        STARTING AT (28,19,0) FACING (90) WALL1 (9 BY H1),
        STARTING AT (28,28,0) FACING (0) WALL1 (28 BY H1),
        STARTING AT (0,28,0) FACING (270) WALL (8 BY H1);
    LIGHTS = 6.26,ADMIN LIGHTS;
    CONTROLS = ADMIN COOL AND HEAT,32 HEATING,25 COOLING;
  PEOPLE = 4,ADMIN OFFICE OCCUPANCY;
  END ZONE;
  ZONE 6 "CONFERENCE 6":
     ORIGIN: (202,10,0);
     NORTH AXIS = 0;
     ROOF:
        STARTING AT (0,0,H1) FACING (180) ROOF (17 BY 9),
        STARTING AT (-13,9,H1) FACING (180) ROOF (30 BY 14);
     FLOOR:
        STARTING AT (0,9,0) FACING (180) FLOOR39 (17 BY 9),
        STARTING AT (-13,23,0) FACING (180) FLOOR39 (30 BY 14);
     PARTITIONS:

        STARTING AT (0,0,0) FACING (180) WALL1 (17 BY H1),
        STARTING AT (17,0,0) FACING (90) WALL1 (23 BY H1),
        STARTING AT (17,23,0) FACING (0) WALL1 (30 BY H1),
        STARTING AT (-13,23,0) FACING (270) WALL1 (14 BY H1),
        STARTING AT (-13,9,0) FACING (180) WALL1 (13 BY H1),
        STARTING AT (0,9,0) FACING (270) WALL1 (9 BY H1);
      LIGHTS = 2.79,ADMIN LIGHTS;
      CONTROLS = ADMIN COOL AND HEAT,2 HEATING,5 COOLING;
   PEOPLE = 2,ADMIN OFFICE OCCUPANCY;
  END ZONE;
  ZONE 7 "CLASSROOM 8":
     ORIGIN:(149,40,0);
     NORTH AXIS = 0;
     ROOF:
        STARTING AT (0,0,0) FACING (180) ROOF (70 BY 37);
     SLAB ON GRADE FLOOR:
        STARTING AT (0,37,0) FACING (180) FLOOR SLAB 4 IN (70 BY 37);
     PARTITIONS:
        STARTING AT (0,0,0) FACING (180) WALL2 (70 BY H1),
        STARTING AT (70,0,0) FACING (90) WALL1 (37 BY H1),
        STARTING AT (0,16,0) FACING (270) WALL2 (16 BY H1);
     EXTERIOR WALLS:
        STARTING AT (70,37,0) FACING (0) WALL (70 BY H1);
     WALLS TO UNCOOLED SPACES:
        STARTING AT (0,37,0) FACING (270) WALL2 (21 BY H1);
     LIGHTS = 13.54,ADMIN LIGHTS;
     CONTROLS = ADMIN COOL AND HEAT,39 HEATING,28 COOLING;
     PEOPLE = 25,ADMIN CLASSROOM OCCUPANCY;
  END ZONE;

  ZONE 102 "STORAGE B":
     ORIGIN: (219,0,0);
     NORTH AXIS=0;
     ROOF:
        STARTING AT (0,0,H1) FACING (180) ROOF (41 BY 77);
     SLAB ON GRADE FLOOR:
        STARTING AT (0,77,0) FACING (180) FLOOR SLAB 4 IN (41 BY 47);
```

```
    FLOOR:
       STARTING AT (0,30,0) FACING (180) FLOOR39 (41 BY 30);
    EXTERIOR WALLS:
       STARTING AT (0,0,0) FACING (180) WALL (41 BY H1),
       STARTING AT (41,0,0) FACING (90) WALL (77 BY H1),
       STARTING AT (41,77,0) FACING (0) WALL (41 BY H1);
    PARTITIONS:
       STARTING AT (0,77,0) FACING (270) WALL1 (77 BY H1);
    LIGHTS = 16.59, ADMIN LIGHTS;
    CONTROLS = ADMIN H ONLY,51 HEATING;
    PEOPLE = 7,ADMIN OFFICE OCCUPANCY;
 END ZONE;
  ZONE 1000 "BASEMENT"
     ORIGIN(77,0,0);
     NORTH AXIS = 0;
     BASEMENT WALLS
        STARTING AT (0,20,0) FACING (180) WALL2 (64 BY 8),
        STARTING AT (64,20,0) FACING (270) WALL2 (20 BY 8),
        STARTING AT (64,0,0) FACING (180) WALL2 (98 BY 8),
        STARTING AT (162,0,0) FACING (90) WALL2 (30 BY 8),
        STARTING AT (162,30,0) FACING  (0) WALL2 (162 BY 8),
        STARTING AT (0,30,0) FACING (270) WALL2 (10 BY 8);
       CEILING
         STARTING AT (0,20,8) FACING (180) CEILING39 (64 BY 10),
         STARTING AT (64,0,8) FACING (180) CEILING39 (98 BY 30);
       SLAB ON GRADE FLOOR
         STARTING AT (0,30,0) FACING (180) FLOOR SLAB 4 IN (64 BY 1
         STARTING AT (64,30,0) FACING (180) FLOOR SLAB 4 IN (98 BY
       CONTROLS = ADMIN H ONLY,32 HEATING;
    PEOPLE = 3,ADMIN OFFICE OCCUPANCY;
       LIGHTS  = 6.26,ADMIN LIGHTS;
  END ZONE;
 END BUILDING DESCRIPTION;
 BEGIN FAN SYSTEM DESCRIPTION;
 MULTIZONE SYSTEM 1 "MAIN" SERVING ZONE 1,2,3,4,5,6,7;
   FOR ZONE 1:
      SUPPLY AIR VOLUME = 3000;
 END;
  FOR ZONE 2:
     SUPPLY AIR VOLUME = 1975;
  END;
  FOR ZONE 3:
     SUPPLY AIR VOLUME = 535;
  END;
  FOR ZONE 4:
     SUPPLY AIR VOLUME = 2405;
  END;
  FOR ZONE 5:
     SUPPLY AIR VOLUME = 2735;
  END;
  FOR ZONE 6:

     SUPPLY AIR VOLUME = 615;
  END;
```

```
 FOR ZONE 7:
    SUPPLY AIR VOLUME = 3000;
 END;
OTHER SYSTEM PARAMETERS:
   SUPPLY FAN EFFICIENCY = .6630;
   HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
   HOT DECK CONTROL SCHEDULE = (200 AT 5,80 AT 70);
   COLD DECK TEMPERATURE = 58;
   COLD DECK THROTTLING RANGE = 16;
   MIXED AIR CONTROL = ENTHALPY ECONOMY CYCLE;
   DESIRED MIXED AIR TEMPERATURE = 55;
END;
   EQUIPMENT SCHEDULES:
        HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE,
                                 -400 MINIMUM TEMPERATURE;
        COOLING COIL OPERATION = ON,58 MINIMUM TEMPERATURE;
        MINIMUM VENTILATION SCHEDULE = OA VENT;
END;
END SYSTEM;
    UNIT VENTILATOR SYSTEM 101 "UNIT HEATER" SERVING ZONE 101;
      FOR ZONE 101
          SUPPLY AIR VOLUME = 500;
          REHEAT CAPACITY = 50000;
      END;
      EQUIPMENT SCHEDULES
      SYSTEM OPERATION = INTERMITTENT;
        HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE;
     END;
     OTHER SYSTEM PARAMETERS
        MIXED AIR CONTROL = FIXED AMOUNT;
        OUTSIDE AIR VOLUME = 0.;
        HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
        HOT DECK CONTROL SCHEDULE = (200 AT 5,80 AT 70);
     END;
END SYSTEM;
    UNIT VENTILATOR SYSTEM 102 "UNIT HEATER" SERVING ZONE 102;
      FOR ZONE 102
          SUPPLY AIR VOLUME = 500;
          REHEAT CAPACITY = 50000;
      END;
      EQUIPMENT SCHEDULES
    SYSTEM OPERATION = INTERMITTENT;
        HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE;
     END;
     OTHER SYSTEM PARAMETERS
        MIXED AIR CONTROL = FIXED AMOUNT;
        OUTSIDE AIR VOLUME = 0.;
        HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
        HOT DECK CONTROL SCHEDULE = (200 AT 5,80 AT 70);
     END;
END SYSTEM;
    SINGLE ZONE DRAW THRU SYSTEM 1000 "BASEMENT" SERVING ZONE 1000;
        FOR ZONE 1000
             SUPPLY AIR VOLUME = 11200;
```

```
        END;
      EQUIPMENT SCHEDULES
        SYSTEM OPERATION = INTERMITTENT,78 MAXIMUM TEMPERATURE,
                          -300 MINIMUM TEMPERATURE;
        HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE;
        COOLING COIL OPERATION = OFF;
        MINIMUM VENTILATION SCHEDULE = CONTINUOUS;
      END;
      OTHER SYSTEM PARAMETERS
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 11200;
SUPPLY FAN EFFICIENCY = .819;
      END;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;
   PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
   OTHER PLANT PARAMETERS;
     REPORT VARIABLES = (1,2,3,4);
   END;
   END PLANT;
END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

```
**          INPUT FILE = ADMIN3
**
**
**
**
**
**         THIS IS A 3 ZONE MODEL
**       OF THE ADMINISTRATION BUILDING.
**
**
**
**
**
**
**
  BEGIN INPUT;
   RUN CONTROL : NEW ZONES, NEW SYSTEMS, PLANT,
      UNITS(IN=ENGLISH,OUT=ENGLISH),
REPORTS (ZONE LOADS,SYSTEM LOADS,COIL LOADS,SYSTEM,PLANT LOADS,
WALLS,ZONE);
DEFINE LOCATION:
   FT CARSON = (LAT=38.75,LONG=104.5,TZ=7);
END;
DEFINE DESIGN DAYS:
      FT CARSON SUMMER = (HIGH=92,LOW=61,WB=59,DATE=21JUL,WEEKDAY,PRES=390),
      FT CARSON WINTER = (HIGH=10,LOW=-2,WB=-2,DATE=21JAN,WEEKEND,PRES=390);
END;
TEMPORARY WALLS:
   WALL = (BRICK - FACE 4 IN,

           AIRSPACE - VERTICAL,
           C8 - 8 IN HW CONCRETE BLOCK);
   WALL1= (E1 - 3/4 IN PLASTER OR GYP BOARD,
           AIRSPACE - VERTICAL,
           E1 - 3/4 IN PLASTER OR GYP BOARD),
   WALL2= (C8 - 8 IN HW CONCRETE BLOCK);
END;
TEMPORARY ROOFS:
   ROOF   = (E2 - 1 / 2 IN SLAG OR STONE,
           E3 - 3 / 8 IN FELT AND MEMBRANE,
           B6 - 2 IN DENSE INSULATION,
           A3 - STEEL SIDING,
           B6 - 2 IN DENSE INSULATION,
           E4 - CEILING AIRSPACE,
           E5 - ACOUSTIC TILE);
END;
TEMPORARY CONTROLS (ADMIN COOL AND HEAT):
   PROFILES:
       CANDH = (1 AT 74, 0 AT 76., -1 AT 78);
   SCHEDULES:
       MONDAY THRU SUNDAY = (00 TO 24 - CANDH),
       HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (ADMIN H ONLY):
```

```
    PROFILES:
      HONLY = (1 AT 74, 0 AT 76);
    SCHEDULES:
       MONDAY THRU SUNDAY = (00 TO 24 - HONLY),
       HOLIDAY = SUNDAY;

END;
 TEMPORARY SCHEDULE (ADMIN OFFICE OCCUPANCY):
      SATURDAY THRU SUNDAY = (00 TO 24 - .2),
      MONDAY THRU FRIDAY = (17 TO 06 - .2,06 TO 08 - .5,08 TO 12
                            12 TO 13 - .67,13 TO 17 - 1.);
 END;
 TEMPORARY SCHEDULE (ADMIN CLASSROOM OCCUPANCY):
      SATURDAY THRU SUNDAY = (00 TO 24 - 0.),
      MONDAY THRU FRIDAY = (11 TO 09 - 0.,09 TO 11 - 1.);
 END;
TEMPORARY SCHEDULE (OA VENT):
       SUNDAY THRU SATURDAY = (00 TO 24 - .5);
END;
 TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - 0.);
 END;
TEMPORARY SCHEDULE (ADMIN LIGHTS):
 MONDAY THRU FRIDAY = (20 TO 07 - .49,.63,08 TO 18 - 1.,.82,.6
 SATURDAY THRU SUNDAY = (00 TO 24 - .49),
   HOLIDAY = SUNDAY;
END;
PROJECT = "ADMIN BUILDING";
LOCATION = FT CARSON;
**
**        GROUND TEMPERATURES FOR RALEIGH,NC (CALHOUN,SC)
**
 GROUND TEMPERATURE = (64,65,65,66,69,72,75,74,74,73,70,67);

**
**
WEATHER TAPE FROM 01JAN THRU 31DEC;
  BEGIN BUILDING DESCRIPTION;
       NORTH AXIS=0.;
       DIMENSIONS: H1=10.75;
       SOLAR DISTRIBUTION = -1;
ZONE 1 "ZONES 1,2,3,4,5,6,7":
   ORIGIN: (0,0,0);
       NORTH AXIS = 0;
   ROOF:
           FACING (180) ROOF (152.52 BY 77);
   SLAB ON GRADE FLOOR:
           FACING (180) FLOOR SLAB 4 IN (129.48 BY 77);
   FLOOR:
           FACING (180) FLOOR39 (23.040 BY 77);
   EXTERIOR WALLS:
           FACING (0) WALL (140 BY H1),
           FACING (90) WALL (20 BY H1),
           FACING (180) WALL (178 BY H1)
            WITH WINDOWS OF TYPE SINGLE PANE WITH BLINDS
```

```
            (31.98 BY H1) AT (0,0),
            FACING (270) WALL (20 BY H1);
      INTERNAL MASS: WALL2 (172  BY H1);
     WALLS TO UNCOOLED SPACES:
            FACING (0) WALL2 (38 BY H1),
            FACING (90) WALL2 (21 BY H1),
            FACING (270) WALL2 (21 BY H1);
INTERNAL MASS: WALL (16 BY H1);

INTERNAL MASS: WALL1 (458.1 BY H1);
LIGHTS = 45.18, ADMIN LIGHTS;
PEOPLE = 50, ADMIN CLASSROOM OCCUPANCY;
PEOPLE = 13,ADMIN OFFICE OCCUPANCY;
CONTROLS = ADMIN COOL AND HEAT,201 HEATING,135 COOLING;
END ZONE;
ZONE 100 "ZONES 101,102":
   ORIGIN (0,0,0);
    NORTH AXIS = 0;
      ROOF:
          FACING (180) ROOF (82 BY 77);
    SLAB ON GRADE FLOOR;
          FACING (180) FLOOR SLAB 4 IN (66.03 BY 77);
    FLOOR:
          FACING (180) FLOOR39 (15.97 BY 77);
    EXTERIOR WALLS:
          FACING (0) WALL (82.01 BY H1),
           FACING (90) WALL (77 BY H1),
          FACING (180) WALL (82.01 BY H1),
          FACING (270) WALL (77 BY H1);
    INTERNAL MASS: WALL1 (154.01 BY H1);
    LIGHTS = 33.18,ADMIN LIGHTS;
    CONTROLS =ADMIN H ONLY,104 HEATING;
    PEOPLE = 14,ADMIN OFFICE OCCUPANCY;
END ZONE;
 ZONE 1000 "BASEMENT"
    ORIGIN(77,0,0);
    NORTH AXIS = 0;
    BASEMENT WALLS

        STARTING AT (0,20,0) FACING (180) WALL2 (64 BY 8),
        STARTING AT (64,20,0) FACING (270) WALL2 (20 BY 8),
        STARTING AT (64,0,0) FACING (180) WALL2 (98 BY 8),
        STARTING AT (162,0,0) FACING (90) WALL2 (30 BY 8),
        STARTING AT (162,30,0) FACING  (0) WALL2 (162 BY 8),
        STARTING AT (0,30,0) FACING (270) WALL2 (10 BY 8);
       CEILING
         STARTING AT (0,20,8) FACING (180) CEILING39 (64 BY 10),
         STARTING AT (64,0,8) FACING (180) CEILING39 (98 BY 30);
       SLAB ON GRADE FLOOR
         STARTING AT (0,30,0) FACING (180) FLOOR SLAB 4 IN (64 BY 10),
         STARTING AT (64,30,0) FACING (180) FLOOR SLAB 4 IN (98 BY 30);
       CONTROLS = ADMIN H ONLY,32 HEATING;
    PEOPLE = 3,ADMIN OFFICE OCCUPANCY;
       LIGHTS  = 6.26,ADMIN LIGHTS;
 END ZONE;
```

```
END BUILDING DESCRIPTION;
**
**
**
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM  1 "MAIN" SERVING ZONE 1;
    FOR ZONE 1:
        SUPPLY AIR VOLUME =  14265;
    END;
 OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .6630;
     HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
     HOT DECK CONTROL SCHEDULE = (200 AT 5,80 AT 70);

     COLD DECK TEMPERATURE = 58;
     COLD DECK THROTTLING RANGE = 16;
     MIXED AIR CONTROL = ENTHALPY ECONOMY CYCLE;
     DESIRED MIXED AIR TEMPERATURE = 55;
 END;
     EQUIPMENT SCHEDULES:
          HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE,
                                 -400 MINIMUM TEMPERATURE;
          COOLING COIL OPERATION = ON,58 MINIMUM TEMPERATURE;
          MINIMUM VENTILATION SCHEDULE = OA VENT;
 END;
 END SYSTEM;
    UNIT VENTILATOR SYSTEM 100 "UNIT HEATER" SERVING ZONE 100;
         FOR ZONE 100:
              SUPPLY AIR VOLUME = 1000;
              REHEAT CAPACITY = 100000;
         END;
         EQUIPMENT SCHEDULES:
              SYSTEM OPERATION = INTERMITTENT;
              HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE;
         END;
         OTHER SYSTEM PARAMETERS:
              MIXED AIR CONTROL =FIXED AMOUNT;
              OUTSIDE AIR VOLUME = 0.;
              HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
              HOT DECK CONTROL SCHEDULE = (200 AT 5, 80 AT 70);
         END;
    END SYSTEM;
    SINGLE ZONE DRAW THRU SYSTEM 1000 "BASEMENT" SERVING ZONE 1000;
        FOR ZONE 1000
             SUPPLY AIR VOLUME = 11200;
        END;
      EQUIPMENT SCHEDULES
       SYSTEM OPERATION = INTERMITTENT,78 MAXIMUM TEMPERATURE,
                            -300 MINIMUM TEMPERATURE;
        HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE;
        COOLING COIL OPERATION = OFF;
        MINIMUM VENTILATION SCHEDULE = CONTINUOUS;
      END;
      OTHER SYSTEM PARAMETERS
```

```
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 11200;
SUPPLY FAN EFFICIENCY = .819;
      END;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
**
**
**
BEGIN CENTRAL PLANT DESCRIPTION;
   PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
   OTHER PLANT PARAMETERS:
     REPORT VARIABLES = (1,2,3,4);
   END;
   END PLANT;
END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

```
**
**       THIS IS A 5 ZONE MODEL
**     OF THE ADMINISTRATION BUILDING.
**
**
**     INTERNAL MASSES   INCLUDED.
**
**
**
**  ZONE 1 OCCUPANCY  58 PEOPLE,ADMIN CLASSROOM OCCUPANCY
**
**
  BEGIN INPUT;
   RUN CONTROL : NEW ZONES, NEW SYSTEMS, PLANT,
      UNITS(IN=ENGLISH,OUT=ENGLISH),
REPORTS (ZONE LOADS,SYSTEM LOADS,COIL LOADS,SYSTEM,PLANT LOADS,
WALLS,ZONE);
DEFINE LOCATION:
   FT CARSON = (LAT=38.75,LONG=104.5,TZ=7);
END;
DEFINE DESIGN DAYS:
      FT CARSON SUMMER = (HIGH=92,LOW=61,WB=59,DATE=21JUL,WEEKDAY,PRES=390),
      FT CARSON WINTER = (HIGH=10,LOW=-2,WB=-2,DATE=21JAN,WEEKEND,PRES=390);
END;
TEMPORARY WALLS:
   WALL = (BRICK - FACE 4 IN,
           AIRSPACE - VERTICAL,
           C8 - 8 IN HW CONCRETE BLOCK);
   WALL1= (E1 - 3/4 IN PLASTER OR GYP BOARD,
           AIRSPACE - VERTICAL,
           E1 - 3/4 IN PLASTER OR GYP BOARD),
   WALL2= (C8 - 8 IN HW CONCRETE BLOCK);
END;
TEMPORARY ROOFS:
   ROOF    = (E2 - 1 / 2 IN SLAG OR STONE,
           E3 - 3 / 8 IN FELT AND MEMBRANE,
           B6 - 2 IN DENSE INSULATION,
           A3 - STEEL SIDING,
           B6 - 2 IN DENSE INSULATION,
           E4 - CEILING AIRSPACE,
           E5 - ACOUSTIC TILE);
END;
TEMPORARY CONTROLS (ADMIN COOL AND HEAT):
   PROFILES:
       CANDH = (1 AT 74, 0 AT 76., -1 AT 78);
   SCHEDULES:
       MONDAY THRU SUNDAY = (00 TO 24 - CANDH),
```

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      HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (ADMIN H ONLY):
   PROFILES:
     HONLY = (1 AT 74, 0 AT 76);

   SCHEDULES:
      MONDAY THRU SUNDAY = (00 TO 24 - HONLY),
      HOLIDAY = SUNDAY;
END;
 TEMPORARY SCHEDULE (ADMIN OFFICE OCCUPANCY):
     SATURDAY THRU SUNDAY = (00 TO 24 - .2),
     MONDAY THRU FRIDAY = (17 TO 06 - .2,06 TO 08 - .5,08 TO 12 - 1.0,
                           12 TO 13 - .67,13 TO 17 - 1.);
 END;
 TEMPORARY SCHEDULE (ADMIN CLASSROOM OCCUPANCY):
     SATURDAY THRU SUNDAY = (00 TO 24 - 0.),
     MONDAY THRU FRIDAY = (11 TO 09 - 0.,09 TO 11 - 1.);
 END;
TEMPORARY SCHEDULE (OA VENT):
      SUNDAY THRU SATURDAY = (00 TO 24 - .5);
END;
 TEMPORARY SCHEDULE (OFF):
    SUNDAY THRU SATURDAY = (00 TO 24 - 0.);
 END;
TEMPORARY SCHEDULE (ADMIN LIGHTS):
 MONDAY THRU FRIDAY = (20 TO 07 - .49,.63,08 TO 18 - 1.,.82,.63),
 SATURDAY THRU SUNDAY = (00 TO 24 - .49),
   HOLIDAY = SUNDAY;
END;
PROJECT = "ADMIN BUILDING";
LOCATION = FT CARSON;
**
**      GROUND TEMPERATURES FOR RALEIGH,NC (CALHOUN,SC)
**
 GROUND TEMPERATURE = (64,65,65,66,69,72,75,74,74,73,70,67);
**
WEATHER TAPE FROM 01JAN THRU 31DEC;
  BEGIN BUILDING DESCRIPTION;
      NORTH AXIS=0.;
      DIMENSIONS: H1=10.75;
      SOLAR DISTRIBUTION = -1;
ZONE 1 "WORK AREAS(ZONES 1,3,4,5,6,7)":
   ORIGIN: (0,0,0);
      NORTH AXIS = 0;
   ROOF:
          FACING (180) ROOF (98.47 BY 77);
   SLAB ON GRADE FLOOR:
          FACING (180) FLOOR SLAB 4 IN (82.87 BY 77);
   FLOOR:
          FACING (180) FLOOR39 (15.60 BY 77);
   EXTERIOR WALLS:
          FACING (0) WALL (140 BY H1),
          FACING (90) WALL (20 BY H1),
```

```
              FACING (180) WALL (116 BY H1)
               WITH WINDOWS OF TYPE SINGLE PANE WITH BLINDS
               (31.98 BY H1) AT (0,0),
              FACING (270) WALL (20 BY H1);
        INTERNAL MASS: WALL1 (246.04 BY H1);
        INTERNAL MASS: WALL2 (172  BY H1);
        INTERNAL MASS: WALL  (16 BY H1);
       WALLS TO UNCOOLED SPACES:

              FACING (90) WALL2 (21 BY H1),
              FACING (270) WALL2 (21 BY H1);
        ROOF:
             FACING (180) ROOF (14.88 BY 77);
        SLAB ON GRADE FLOOR:
             FACING (180) FLOOR SLAB 4 IN (7.44 BY 77);
              INTERNAL MASS WALL1 (212.04 BY H1);
        FLOOR:
             FACING (180) FLOOR39 (7.44 BY 77);
    LIGHTS = 45.2, ADMIN LIGHTS;
    PEOPLE = 58, ADMIN CLASSROOM OCCUPANCY;
    PEOPLE = 4,ADMIN OFFICE OCCUPANCY;
    CONTROLS = ADMIN COOL AND HEAT,148 HEATING,116 COOLING;
    END ZONE;
    ZONE 2 "HALLWAY":
       ORIGIN (0,0,0);
    NORTH AXIS = 0;
        ROOF:
             FACING (180) ROOF (39.17 BY 77);
        SLAB ON GRADE FLOOR:
             FACING (180) FLOOR SLAB 4 IN (39.17 BY 77);
        EXTERIOR WALLS:
             FACING (180) WALL (62 BY H1);
        WALLS TO UNCOOLED SPACES:
             FACING (0) WALL2 (38 BY H1);
    PEOPLE = 1,ADMIN OFFICE OCCUPANCY;
    CONTROLS =ADMIN COOL AND HEAT,53 HEATING,19 COOLING;
    END ZONE;
    ZONE 100 "STORAGE AREAS":

       ORIGIN (0,0,0);
        NORTH AXIS = 0;
          ROOF:
             FACING (180) ROOF (82 BY 77);
        SLAB ON GRADE FLOOR:
             FACING (180) FLOOR SLAB 4 IN (66.03 BY 77);
        FLOOR:
             FACING (180) FLOOR39 (15.97 BY 77);
        EXTERIOR WALLS:
             FACING (0) WALL (82.01 BY H1),
              FACING (90) WALL (77 BY H1),
             FACING (180) WALL (82.01 BY H1),
             FACING (270) WALL (77 BY H1);
        INTERNAL MASS: WALL1 (154.01 BY H1);
        LIGHTS = 33.18,ADMIN LIGHTS;
        CONTROLS =ADMIN H ONLY,104 HEATING;
```

```
   PEOPLE = 14,ADMIN OFFICE OCCUPANCY;
END ZONE;
 ZONE 1000 "BASEMENT"
   ORIGIN(77,0,0);
   NORTH AXIS = 0;
   BASEMENT WALLS
      STARTING AT (0,20,0) FACING (180) WALL2 (64 BY 8),
      STARTING AT (64,20,0) FACING (270) WALL2 (20 BY 8),
      STARTING AT (64,0,0) FACING (180) WALL2 (98 BY 8),
      STARTING AT (162,0,0) FACING (90) WALL2 (30 BY 8),
      STARTING AT (162,30,0) FACING  (0) WALL2 (162 BY 8),
      STARTING AT (0,30,0) FACING (270) WALL2 (10 BY 8);
   INTERNAL MASS: WALL1 (154.01 BY H1);

     CEILING
       STARTING AT (0,20,8) FACING (180) CEILING39 (64 BY 10),
       STARTING AT (64,0,8) FACING (180) CEILING39 (98 BY 30);
     SLAB ON GRADE FLOOR
       STARTING AT (0,30,0) FACING (180) FLOOR SLAB 4 IN (64 BY 10),
       STARTING AT (64,30,0) FACING (180) FLOOR SLAB 4 IN (98 BY 30);
     CONTROLS = ADMIN H ONLY,32 HEATING;
   PEOPLE = 3,ADMIN OFFICE OCCUPANCY;
     LIGHTS  = 6.26,ADMIN LIGHTS;
 END ZONE;
END BUILDING DESCRIPTION;
**
**
**
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM  1 "MAIN" SERVING ZONES 1,2;
   FOR ZONE 1:
       SUPPLY AIR VOLUME =  12290;
   END;
   FOR ZONE 2:
        SUPPLY AIR VOLUME = 1975;
   END;
 OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .6630;
     HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
     HOT DECK CONTROL SCHEDULE = (200 AT 5,80 AT 70);
     COLD DECK TEMPERATURE = 58;
     COLD DECK THROTTLING RANGE = 16;
     MIXED AIR CONTROL = ENTHALPY ECONOMY CYCLE;

     DESIRED MIXED AIR TEMPERATURE = 55;
 END;
     EQUIPMENT SCHEDULES:
          HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE,
                                -400 MINIMUM TEMPERATURE;
          COOLING COIL OPERATION = ON,58 MINIMUM TEMPERATURE;
          MINIMUM VENTILATION SCHEDULE = OA VENT;
 END;
 END SYSTEM;
   UNIT VENTILATOR SYSTEM 100 "UNIT HEATER" SERVING ZONE 100;
        FOR ZONE 100:
```

```
                SUPPLY AIR VOLUME = 1000;
                REHEAT CAPACITY = 100000;
           END;
           EQUIPMENT SCHEDULES:
                SYSTEM OPERATION = INTERMITTENT;
                HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE;
           END;
           OTHER SYSTEM PARAMETERS:
                MIXED AIR CONTROL =FIXED AMOUNT;
                OUTSIDE AIR VOLUME = 0.;
                HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
                HOT DECK CONTROL SCHEDULE = (200 AT 5, 80 AT 70);
           END;
      END SYSTEM;
      SINGLE ZONE DRAW THRU SYSTEM 1000 "BASEMENT" SERVING ZONE 1000;
          FOR ZONE 1000
               SUPPLY AIR VOLUME = 11200;
          END;

        EQUIPMENT SCHEDULES
         SYSTEM OPERATION = INTERMITTENT,78 MAXIMUM TEMPERATURE,
                         -300 MINIMUM TEMPERATURE;
          HEATING COIL OPERATION = CONTINUOUS,78 MAXIMUM TEMPERATURE;
          COOLING COIL OPERATION = OFF;
          MINIMUM VENTILATION SCHEDULE = CONTINUOUS;
        END;
        OTHER SYSTEM PARAMETERS
        MIXED AIR CONTROL = FIXED AMOUNT;
        OUTSIDE AIR VOLUME = 11200;
SUPPLY FAN EFFICIENCY = .819;
        END;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
**
**
**
BEGIN CENTRAL PLANT DESCRIPTION;
   PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
   OTHER PLANT PARAMETERS:
     REPORT VARIABLES = (1,2,3,4);
   END;
   END PLANT;
END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

APPENDIX C: BLAST INPUT MODELS FOR THE DENTAL CLINIC

```
**
**              INPUT FILE = DCNCBI
**
**        THIS IS THE DENTAL CLINIC USED IN THE BLAST VALIDATION  (7/9/81)
**        STUDIES.
**
**
**
**
**
**        THE AMOUNT OF HEATING AND COOLING IS SET TO KEEP THE
**        BUILDING TEMPERATURE BETWEEN 66 AND 78F ALL YEAR.
**
BEGIN INPUT;
RUN CONTROL:  NEW ZONES, NEW AIR SYSTEMS, PLANT,
  UNITS(IN = ENGLISH, OUT = ENGLISH),
REPORTS(ZONE LOADS,SYSTEM,SYSTEM LOADS,COIL LOADS,PLANT LOADS, WALLS, ZONE);
       TEMPORARY LOCATION:
          RALNC = (LAT = 35.83, LONG = 78.83, TZ = 5);
       END;
       TEMPORARY DESIGN DAYS:
          RALNCSUM = (HIGH= 92, LOW= 71, WB= 75, DATE= 21JUL,
                      PRES= 405, WS= 440, DIR= 270,
                      CLEARNESS= 1, WEEKDAY);
          RALNCWIN = (HIGH= 29, LOW= 14, WB= 10, DATE= 21JAN,
                      PRES= 405, WS= 1320, DIR= 325,
                      CLEARNESS= .1, WEEKEND),
       END;
  TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - OFF),
     HOLIDAY = SUNDAY;
  END;
TEMPORARY SCHEDULE (ALL ZONES PEOPLE):
       MONDAY THRU FRIDAY = (17 TO 07 - 0.,.5,.94,.92,.79,.52,.56,.75,
                             .68,.61,.28),
       SATURDAY THRU SUNDAY = (00 TO 24 - 0),
       HOLIDAY = SUNDAY;
END;
TEMPORARY SCHEDULE (CLINIC LIGHTS AND EQUIPMENT):
 MONDAY THRU FRIDAY = (19 TO 07 - .34,.58,.98,.98,.98,.86,
                       .72,.91,.98,.95,.79,.40,.40),
       SATURDAY THRU SUNDAY = (00 TO 24 - .34),
       HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (CLINIC CONTROLS):
       PROFILES:
         CONSTANT = (1 AT 66, 0 AT 68, -.125 AT 70, -1 AT 140);
       SCHEDULES:
          MONDAY THRU SUNDAY = (00 TO 24 - CONSTANT),
          HOLIDAY = SUNDAY;
END;
TEMPORARY WALLS:
       EWALL1 = (BRICK - FACE 4 IN,
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                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    C3 - 4 IN HW CONCRETE BLOCK,

                    B1 - AIRSPACE RESISTANCE,
                    BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL1 = (BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN,
                    B1 - AIRSPACE RESISTANCE,
                    BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL2 = (C8 - 8 IN HW CONCRETE BLOCK,
                    B1 - AIRSPACE RESISTANCE,
                    BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      CPWALL = (A1 - 1 IN STUCCO,
                    C10 - 8 IN HW CONCRETE,
                    E1 - 3 / 4 IN PLASTER OR GYP BOARD));
END;
TEMPORARY ROOFS:
      ROOF1 = (E2 - 1/ 2 IN SLAG OR STONE,
                  E3 - 3/8 IN FELT AND MEMBRANE,
                  A3 - STEEL SIDING,
                  E4 - CEILING AIRSPACE,
                  B4 - 3 IN INSULATION,
                  E5 - ACOUSTIC TILE),
      CPCEIL =(FINISH FLOORING - TILE 1/16 IN,
                  C10 - 8 IN HW CONCRETE,
                  B1 - AIRSPACE RESISTANCE,
                  B2 - 1 IN INSULATION));
END;
TEMPORARY FLOORS:
      FLOOR1 = (B2 - 1 IN INSULATION,
                    B1 - AIRSPACE RESISTANCE,
                    C10 - 8 IN HW CONCRETE,
                    FINISH FLOORING - TILE 1/16 IN),

      CPFLOOR = (DIRT 12 IN);
END;
TEMPORARY DOORS:
      WINDOW PANEL = (GLASS - HEAT ABSORBING PLATE 1/ 2 IN,
                          INSULATION - CELLULAR GLASS 2 IN,
                          C3 - 4 IN HW CONCRETE BLOCK,
                          BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN);
END;
   PROJECT= "DENTAL CLINIC - FT BRAGG NC";
   LOCATION = RALNC;
    GROUND TEMPERATURE = (59,60,61,62,66,70,74,72,69,66,64,61);
    WEATHER TAPE FROM 01JAN THRU 31DEC;
**
BEGIN BUILDING DESCRIPTION;
      NORTH AXIS = 0.;
      DIMENSIONS: HEIGHT1 = 9., N = 0, E = 90, S = 180, W = 270;
CRAWL SPACE 1000 "CRAWL SPACE":
      ORIGIN:(0,0,-2.5);
      NORTH AXIS = 0;
```

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   CRAWL SPACE CEILING:
      STARTING AT (0,0,2.5) FACING (S) CPCEIL (92 BY 102);
   SLAB ON GRADE FLOOR:
      STARTING AT (0,102,0) FACING (S) CPFLOOR (92 BY 102);
   BASEMENT WALLS:
      STARTING AT (0,0,0) FACING (S) CPWALL (92 BY 2.5),
      STARTING AT (92,0,0) FACING (E) CPWALL (102 BY 2.5),
      STARTING AT (92,102,0) FACING (N) CPWALL (92 BY 2.5),
      STARTING AT (0,102,0) FACING (W) CPWALL (102 BY 2.5);
END ZONE;

ZONE 1 "NORTH LAB":
      ORIGIN:(14,83,0);
      NORTH AXIS = 0;
   EXTERIOR WALLS:
      STARTING AT (31,19.,0) FACING (N) EWALL1 (31 BY HEIGHT1)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (10,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (10,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (3.33 BY 4.25) AT (27.5,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (3.33 BY 4.0) AT (27.5,0)
         WITH OVERHANGS (50 BY 3) AT (-10,HEIGHT1);
   PARTITIONS:
      STARTING AT (31,0,0) FACING (E) PWALL2 (19. BY HEIGHT1),
      STARTING AT (0,0,0) FACING (S) PWALL1 (31 BY HEIGHT1),
      STARTING AT (0,19.,0) FACING (W) PWALL1 (19 BY HEIGHT1);
   ROOFS:
      STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (31 BY 19.);
   FLOOR OVER CRAWL SPACE:
      STARTING AT (0,19.,0) FACING (S) FLOOR1 (31 BY 19.);
      PEOPLE = 4,ALL ZONES PEOPLE;
      ELECTRIC EQUIPMENT = 10.24,CLINIC LIGHTS AND EQUIPMENT;
      LIGHTS = 5.73,CLINIC LIGHTS AND EQUIPMENT;
      CONTROLS = CLINIC CONTROLS, 0 HEATING, 75.4 COOLING;
END ZONE;
ZONE 2 "NORTH WEST LAB":
      ORIGIN:(0,83,0);

      NORTH AXIS = 0;
   EXTERIOR WALLS:
      STARTING AT (0,0,0) FACING (S) EWALL1 (4 BY HEIGHT1)
         WITH OVERHANGS (7 BY 83) AT (-3,HEIGHT1)
         WITH WINGS (HEIGHT1 BY 83) AT (4,0),
      STARTING AT (0,19,0) FACING (W) EWALL1 (19 BY HEIGHT1)
         WITH OVERHANGS (108 BY 3) AT (-3,HEIGHT1),
      STARTING AT (14,19,0) FACING (N) EWALL1 (14 BY HEIGHT1)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (3.33 BY 4.25) AT (.5,4)
         WITH DOOR OF TYPE WINDOW PANEL
            (3.33 BY 4.0) AT (.5,0)
         WITH OVERHANGS (60 BY 3) AT (-42,HEIGHT1);
   PARTITIONS:
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      STARTING AT (14,6.5,0) FACING (E) PWALL1 (11.5 BY HEIGHT1),
      STARTING AT (4,0,0) FACING (S) PWALL1 (10 BY HEIGHT1);
   ROOFS:
      STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (14 BY 19);
   FLOOR OVER CRAWL SPACE:
      STARTING AT (0,19,0) FACING (S) FLOOR1 (14 BY 19);
   PEOPLE = 2,ALL ZONES PEOPLE;
   LIGHTS = 2.18,CLINIC LIGHTS AND EQUIPMENT;
  ELECTRIC EQUIPMENT = 6.82,CLINIC LIGHTS AND EQUIPMENT;
  GAS EQUIPMENT = 5,CLINIC LIGHTS AND EQUIPMENT;
   CONTROLS = CLINIC CONTROLS, 0 HEATING, 65 COOLING;
END ZONE;
ZONE 3 "WEST OPER RMS":
      ORIGIN:(0,13,0);
      NORTH AXIS = 0.;

   EXTERIOR WALLS:
      STARTING AT (0,70,0) FACING (W) EWALL1 (70 BY HEIGHT1)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (5 BY 8.9) REVEAL (3.67) AT (.5,0.05)
         WITH OVERHANGS (87  BY 3) AT (-16,HEIGHT1)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (13,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (13,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (33,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (33,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (53,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (53,0);
   PARTITIONS:
      STARTING AT (0,0,0) FACING (S) PWALL1 (19 BY HEIGHT1),
      STARTING AT (19,5,0) FACING (E) PWALL1 (59 BY HEIGHT1),
      STARTING AT (19,70,0) FACING (N) PWALL1 (19 BY HEIGHT1);
   ROOFS:
      STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (19 BY 70);
   FLOOR OVER CRAWL SPACE:
      STARTING AT (0,70,0) FACING (S) FLOOR1 (19 BY 70);
   PEOPLE = 11,ALL ZONES PEOPLE;
   LIGHTS = 7.14,CLINIC LIGHTS AND EQUIPMENT;
   ELECTRIC EQUIPMENT = 3.41,CLINIC LIGHTS AND EQUIPMENT;
   CONTROLS = CLINIC CONTROLS, 9 HEATING, 65.8 COOLING;

END ZONE;
ZONE 4 "LOCKER RMS":
      ORIGIN:(18,19,0);
      NORTH AXIS = 0.;
   PARTITIONS:
      STARTING AT (0,0,0) FACING (S) PWALL1 (13 BY HEIGHT1),
      STARTING AT (13,0,0) FACING (E) PWALL1 (59 BY HEIGHT1),
      STARTING AT (13,59,0) FACING (N) PWALL1 (13 BY HEIGHT1),
      STARTING AT (0,59,0) FACING (W) PWALL1 (59 BY HEIGHT1);
```

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    ROOFS:
        STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (13 BY 59);
    FLOOR OVER CRAWL SPACE:
        STARTING AT (0,59,0) FACING (S) FLOOR1 (13 BY 59);
    PEOPLE = 2,ALL ZONES PEOPLE;
    LIGHTS = 3.96,CLINIC LIGHTS AND EQUIPMENT;
    ELECTRIC EQUIPMENT = 0,CLINIC LIGHTS AND EQUIPMENT;
    CONTROLS = CLINIC CONTROLS, 1 HEATING, 15.2 COOLING;
END ZONE;
ZONE 5 "LIBRARY CONF RMS":
        ORIGIN:(31,47,0);
        NORTH AXIS = 0;
    PARTITIONS:
        STARTING AT (0,0,0) FACING (S) PWALL1 (6 BY HEIGHT1),
        STARTING AT (6,0,0) FACING (E) PWALL1 (3 BY HEIGHT1),
        STARTING AT (6,3,0) FACING (S) PWALL1 (12 BY HEIGHT1),
        STARTING AT (18,3,0) FACING (E) PWALL1 (29 BY HEIGHT1),
        STARTING AT (18,36,0) FACING (N) PWALL1 (30 BY HEIGHT1),
        STARTING AT (-12,36,0) FACING (W) PWALL1 (6 BY HEIGHT1),
        STARTING AT (-12,30,0) FACING (S) PWALL1 (12 BY HEIGHT1),

        STARTING AT (0,30,0) FACING (W) PWALL1 (30 BY HEIGHT1);
    ROOFS:
        STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (6 BY 3),
        STARTING AT (0,3,HEIGHT1) FACING (S) ROOF1 (18 BY 33),
        STARTING AT (-12,30,HEIGHT1) FACING (S) ROOF1 (12 BY 6);
    FLOORS OVER CRAWL SPACE:
        STARTING AT (0,3,0) FACING (S) FLOOR1 (6 BY 3),
        STARTING AT (0,36,0) FACING (S) FLOOR1 (18 BY 33),
        STARTING AT (-12,36,0) FACING (S) FLOOR1 (12 BY 6);
    PEOPLE = 4,ALL ZONES PEOPLE;
    LIGHTS = 3.28,CLINIC LIGHTS AND EQUIPMENT;
    ELECTRIC EQUIPMENT = 3.41,CLINIC LIGHTS AND EQUIPMENT;
    CONTROLS = CLINIC CONTROLS, 1 HEATING, 26.5 COOLING;
END ZONE;
ZONE 6 "WAITING ROOM":
        ORIGIN:(19,13,0);
        NORTH AXIS = 0.;
    PARTITIONS:
        STARTING AT (0,0,0) FACING (S) PWALL1 (42 BY HEIGHT1),
        STARTING AT (42,5.5,0) FACING (N) PWALL1 (12 BY HEIGHT1),
        STARTING AT (30,5.5,0) FACING (E) PWALL1 (31 BY HEIGHT1),
        STARTING AT (30,36.5,0) FACING (N) PWALL1 (12 BY HEIGHT1),
        STARTING AT (18,36.5,0) FACING (W) PWALL1 (3 BY HEIGHT1),
        STARTING AT (18,33.5,0) FACING (N) PWALL1  (6 BY HEIGHT1),
        STARTING AT (12,33.5,0) FACING (W) PWALL1 (28 BY HEIGHT1),
        STARTING AT (12,5.5,0) FACING (N) PWALL1 (12 BY HEIGHT1);
    ROOFS:
        STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (42 BY 5.5),
        STARTING AT (12,5.5,HEIGHT1) FACING (S) ROOF1 (18 BY 28),

        STARTING AT (18,33.5,HEIGHT1) FACING (S) ROOF1 (12 BY 3);
    FLOORS OVER CRAWL SPACE:
        STARTING AT (0,5.5,0) FACING (S) FLOOR1 (42 BY 5.5),
        STARTING AT (12,33.5,0) FACING (S) FLOOR1 (18 BY 28),
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        STARTING AT (18,36.5,0) FACING (S) FLOOR1 (12 BY 5);
    PEOPLE = 31,ALL ZONES PEOPLE;
    LIGHTS = 2.73,CLINIC LIGHTS AND EQUIPMENT;
    ELECTRIC EQUIPMENT = 1.82,CLINIC LIGHTS AND EQUIPMENT;
    CONTROLS = CLINIC CONTROLS, 8 HEATING, 32.2 COOLING;
END ZONE;
ZONE 7 "RECORDS AND SUPPLY":
        ORIGIN:(49,18.5,0);
        NORTH AXIS = 0.;
    PARTITIONS:
        STARTING AT (0,0,0) FACING (S) PWALL1 (12 BY HEIGHT1),
        STARTING AT (12,0,0) FACING (E) PWALL1 (45 BY HEIGHT1),
        STARTING AT (12,45,0) FACING (S) PWALL1 (6 BY HEIGHT1),
        STARTING AT (18,45,0) FACING (E) PWALL1 (13 BY HEIGHT1),
        STARTING AT (18,58,0) FACING (S) PWALL1 (7 BY HEIGHT1),
        STARTING AT (25,64.5,0) FACING (N) PWALL2 (25 BY HEIGHT1),
        STARTING AT (0,64.5,0) FACING (W) PWALL1 (64.5 BY HEIGHT1);
    ROOFS:
        STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (12 BY 64.5),
        STARTING AT (12,45,HEIGHT1) FACING (S) ROOF1 (6 BY 18.5),
        STARTING AT (18,58,HEIGHT1) FACING (S) ROOF1 (7 BY 5.5);
    FLOORS OVER CRAWL SPACE:
        STARTING AT (0,64.5,0) FACING (S) FLOOR1 (12 BY 64.5),
        STARTING AT (12,64.5,0) FACING (S) FLOOR1 (6 BY 18.5),
        STARTING AT (18,64.5,0) FACING (S) FLOOR1 (7 BY 5.5);

    PEOPLE = 7,ALL ZONES PEOPLE;
    LIGHTS = 4.37,CLINIC LIGHTS AND EQUIPMENT;
    ELECTRIC EQUIPMENT = 3.41,CLINIC LIGHTS AND EQUIPMENT;
    CONTROLS = CLINIC CONTROLS, 5 HEATING, 30.9 COOLING;
END ZONE;
ZONE 8 "XRAY":
        ORIGIN:(61,13,0);
        NORTH AXIS = 0.;
   PARTITIONS:
        STARTING AT (0,0,0) FACING (S) PWALL1 (16 BY HEIGHT1),
        STARTING AT (16,0,0) FACING (E) PWALL1 (69 BY HEIGHT1),
        STARTING AT (16,69,0) FACING (N) PWALL2 (4 BY HEIGHT1),
        STARTING AT (12,64,0) FACING (N) PWALL1 (7 BY HEIGHT1),
        STARTING AT (5,64,0) FACING (W) PWALL1 (14 BY HEIGHT1),
        STARTING AT (5,50,0) FACING (N) PWALL1 (5 BY HEIGHT1),
        STARTING AT (0,50,0) FACING (W) PWALL1 (45 BY HEIGHT1);
    ROOFS:
        STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (16 BY 50),
        STARTING AT (5,50,HEIGHT1) FACING (S) ROOF1 (11 BY 14),
        STARTING AT (12,64,HEIGHT1) FACING (S) ROOF1 (4 BY 5);
    FLOORS OVER CRAWL SPACE:
        STARTING AT (0,50,0) FACING (S) FLOOR1 (16 BY 50),
        STARTING AT (5,64,0) FACING (S) FLOOR1 (11 BY 14),
        STARTING AT (12,69,0) FACING (S) FLOOR1 (4 BY 5);
    PEOPLE = 5,ALL ZONES PEOPLE;
    LIGHTS = 3.96,CLINIC LIGHTS AND EQUIPMENT;
    ELECTRIC EQUIPMENT = 28.87,CLINIC LIGHTS AND EQUIPMENT;
    CONTROLS = CLINIC CONTROLS, 0 HEATING, 149 COOLING;
END ZONE;
```

```
ZONE 9 "SOUTH OPER RMS":
      ORIGIN:(0,0,0);
      NORTH AXIS = 0.;
   EXTERIOR WALLS:
      STARTING AT (0,0,0) FACING (S) EWALL1 (92 BY HEIGHT1)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (9,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (9,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (28,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (28,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (8 BY 8.9) REVEAL (4) AT (42,.05)
         WITH OVERHANGS (98 BY 3) AT (-3,HEIGHT1)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (58,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (58,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (78,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (78,0),
      STARTING AT (92,0,0) FACING (E) EWALL1 (13.5 BY HEIGHT1)
         WITH OVERHANGS (100 BY 3) AT (-3,HEIGHT1),
      STARTING AT (0,13.5,0) FACING (W) EWALL1 (13.5 BY HEIGHT1)
         WITH OVERHANGS (100 BY 3) AT (-93.5,HEIGHT1);
   PARTITIONS:

      STARTING AT (92,13.5,0) FACING (N) PWALL1 (92 BY HEIGHT1);
   ROOFS:
      STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (92 BY 13.5);
   FLOOR OVER CRAWL SPACE:
      STARTING AT (0,13.5,0) FACING (S) FLOOR1 (92 BY 13.5);
   PEOPLE = 11,ALL ZONES PEOPLE;
   LIGHTS = 9.28,CLINIC LIGHTS AND EQUIPMENT;
   ELECTRIC EQUIPMENT = 3.41,CLINIC LIGHTS AND EQUIPMENT;
   CONTROLS = CLINIC CONTROLS, 13 HEATING, 79.5 COOLING;
END ZONE;
ZONE 10 "EAST OPER RMS":
      ORIGIN:(77,13,0);
      NORTH AXIS = 0.;
   PARTITIONS:
      STARTING AT (0,0,0) FACING (S) PWALL1 (15 BY HEIGHT1),
      STARTING AT (0,70,0) FACING (W) PWALL1 (70 BY HEIGHT1),
      STARTING AT (15,70,0) FACING (N) PWALL2 (15 BY HEIGHT1);
   EXTERIOR WALLS:
      STARTING AT (15,0,0) FACING (E) EWALL1 (70 BY HEIGHT1)
        WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (12,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (12,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
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            (6.66 BY 4.25) AT (32,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (32,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (6.66 BY 4.25) AT (51,4)
         WITH DOORS OF TYPE WINDOW PANEL
            (6.66 BY 4.0) AT (51,0)
         WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
            (5 BY 8.9) REVEAL (3.67) AT (65,0)
         WITH OVERHANGS (76 BY 3) AT (-3,HEIGHT1);
   ROOFS:
      STARTING AT (0,0,HEIGHT1) FACING (S) ROOF1 (15 BY 70);
   FLOOR OVER CRAWL SPACE:
      STARTING AT (0,70,0) FACING (S) FLOOR1 (15 BY 70);
   PEOPLE = 8,ALL ZONES PEOPLE;
   LIGHTS = 6.41,CLINIC LIGHTS AND EQUIPMENT;
   ELECTRIC EQUIPMENT = 3.41,CLINIC LIGHTS AND EQUIPMENT;
   CONTROLS = CLINIC CONTROLS, 8 HEATING, 61.8 COOLING;
END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM 1 "MAIN FAN SYSTEM" SERVING ZONES 1,2,3,4,5,6,7,8,9,10;
FOR ZONE 1:
      EXHAUST AIR VOLUME = 1000;
      SUPPLY AIR VOLUME = 1784;
END;
FOR ZONE 2:
      SUPPLY AIR VOLUME = 406;
END;
FOR ZONE 3:
      SUPPLY AIR VOLUME = 2010;
END;
FOR ZONE 4:
      EXHAUST AIR VOLUME = 600;

      SUPPLY AIR VOLUME = 761;
END;
FOR ZONE 5:
      SUPPLY AIR VOLUME = 502;
END;
FOR ZONE 6:
      SUPPLY AIR VOLUME = 833;
END;
FOR ZONE 7:
      SUPPLY AIR VOLUME = 884;
END;
FOR ZONE 8:
      SUPPLY AIR VOLUME = 829;
END;
FOR ZONE 9:
      SUPPLY AIR VOLUME = 2245;
END;
FOR ZONE 10:
      SUPPLY AIR VOLUME = 2105;
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END;
 EQUIPMENT SCHEDULES:
         SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
         HEATING COIL OPERATION = OFF, FROM 01MAY THRU 25SEP;
 END;
OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .38;
      HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
      HOT DECK CONTROL SCHEDULE = (120 AT 10, 80 AT 70);
      COLD DECK CONTROL = FIXED SET POINT;

      COLD DECK TEMPERATURE = 60.;
    COLD DECK THROTTLING RANGE = 5;
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 4114.;
END;
COOLING COIL DESIGN PARAMETERS:
      COIL TYPE = DX;
      ENTERING AIR DRY BULB TEMPERATURE = 87.6;
      ENTERING AIR WET BULB TEMPERATURE = 70.3;
      LEAVING AIR DRY BULB TEMPERATURE = 61.;
      LEAVING AIR WET BULB TEMPERATURE = 59.;
      AIR FACE VELOCITY = 514.6;
      AIR VOLUME FLOW RATE = 15760;
      BAROMETRIC PRESSURE = 405;
      LEAVING REFRIGERANT TEMPERATURE=45.;
      ENTERING REFRIGERANT TEMPERATURE = 45;
      TOTAL COOLING LOAD = 600;
      NUMBER OF TUBE CIRCUITS=20;
END;
DX CONDENSING UNIT PARAMETERS:
      RPWRCD(.40349281,.21287191,.39339793);
      DESIGN SATURATED SUCTION TEMPERATURE=40;
      DESIGN SATURATED CONDENSING TEMPERATURE=130;
      DESIGN FULL LOAD POWER RATIO=.351;
      DX CONDENSING UNIT CAPACITY=600;
END DX CONDENSING UNIT PARAMETERS;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;

     PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
      EQUIPMENT SELECTION:
         1 BOILER OF SIZE 100;
      END EQUIPMENT SELECTION;
         OTHER PLANT PARAMETERS:
            REPORT VARIABLES = (1,2,3,4,8);
         END;
     END PLANT;
  END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

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**
**                  INPUT FILE = DCNCE1I
**
**        THIS IS THE DENTAL CLINIC USED IN THE BLAST VALIDATION  (7/8/81)
**        STUDIES.   IT HAS BEEN SIMPLIFIED TO A ONE ZONE MODEL.
**        THE WALL/FLOOR/PEOPLE/ETC. HAVE ALL BEEN LUMPED TOGETHER.
**        THE FAN SYSTEM HAS NOT BEEN MODIFIED.  HOWEVER, THE CRAWL
**        SPACE HAS BEEN REMOVED.
**
**
**        THE SYSTEM OPERATION SCHEDULE WAS CHANGED FROM DEFAULT     (7/8/81)
**        TO "OFF" AND THE HEATING COIL SCHEDULE WAS CHANGED FROM
**        THAT FOR FT. HOOD TO THAT USED FOR RALEIGH, NC.
**
**        THE AMOUNT OF HEATING AND COOLING IS SET TO KEEP THE
**        BUILDING TEMPERATURE BETWEEN 66 AND 78F ALL YEAR.
**
**        THE FLOOR ABOVE A CRAWL SPACE WAS REPLACED WITH A FLOOR    (7/24/81)
**
BEGIN INPUT;
RUN CONTROL:  NEW ZONES,
              NEW AIR SYSTEMS,
           PLANT,
  UNITS(OUT=ENGLISH),
REPORTS(ZONE LOADS,SYSTEM,SYSTEM LOADS,COIL LOADS,PLANT LOADS, WALLS, ZONE);
      TEMPORARY LOCATION:
    RALNC = (LAT = 35.83, LONG = 78.83, TZ = 5);
      END;
      TEMPORARY DESIGN DAYS:

         RALNCSUM = (HIGH= 92, LOW= 71, WB= 75, DATE= 21JUL,
                     PRES= 405, WS= 440, DIR= 270,
                     CLEARNESS= 1, WEEKDAY);
         RALNCWIN = (HIGH= 29, LOW= 14, WB= 10, DATE= 21JAN,
                     PRES= 405, WS= 1320, DIR= 325,
                     CLEARNESS= .1, WEEKEND);
      END;
  TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - OFF),
     HOLIDAY = SUNDAY;
  END;
TEMPORARY SCHEDULE (ALL ZONES PEOPLE):
      MONDAY THRU FRIDAY = (17 TO 07 - 0.,.5,.94,.92,.79,.52,.56,.75,
                           .68,.61,.28),
      SATURDAY THRU SUNDAY = (00 TO 24 - 0),
      HOLIDAY = SUNDAY;
END;
TEMPORARY SCHEDULE (CLINIC LIGHTS AND EQUIPMENT):
 MONDAY THRU FRIDAY = (19 TO 07 - .34,.58,.98,.98,.98,.86,
                        .72,.91,.98,.95,.79,.40,.40),
      SATURDAY THRU SUNDAY = (00 TO 24 - .34),
      HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (CLINIC CONTROLS):
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        PROFILES:
          CONSTANT = (1 AT 66, 0 AT 68, -.125 AT 70, -1 AT 140);
        SCHEDULES:
          MONDAY THRU SUNDAY = (00 TO 24 - CONSTANT),
          HOLIDAY = SUNDAY;
END;
TEMPORARY WALLS:
        EWALL1 = (BRICK - FACE 4 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  C3 - 4 IN HW CONCRETE BLOCK,
                  B1 - AIRSPACE RESISTANCE,
                  BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
        PWALL1 = (BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN,
                  B1 - AIRSPACE RESISTANCE,
                  BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
        PWALL2 = (C8 - 8 IN HW CONCRETE BLOCK,
                  B1 - AIRSPACE RESISTANCE,
                  BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
        CPWALL = (A1 - 1 IN STUCCO,
                  C10 - 8 IN HW CONCRETE,
                  E1 - 3 / 4 IN PLASTER OR GYP BOARD);
END;
TEMPORARY ROOFS:
        ROOF1 = (E2 - 1/ 2 IN SLAG OR STONE,
                 E3 - 3/8 IN FELT AND MEMBRANE,
                 A3 - STEEL SIDING,
                 E4 - CEILING AIRSPACE,
                 B4 - 3 IN INSULATION,
                 E5 - ACOUSTIC TILE),
        CPCEIL =(FINISH FLOORING - TILE 1/16 IN,
                 C10 - 8 IN HW CONCRETE,

                 B1 - AIRSPACE RESISTANCE,
                 B2 - 1 IN INSULATION);
END;
TEMPORARY FLOORS:
        FLOOR1 = (B2 - 1 IN INSULATION,
                  B1 - AIRSPACE RESISTANCE,
                  C10 - 8 IN HW CONCRETE,
                  FINISH FLOORING - TILE 1/16 IN),
        CPFLOOR = (DIRT 12 IN);
END;
TEMPORARY DOORS:
        WINDOW PANEL = (GLASS - HEAT ABSORBING PLATE 1/ 2 IN,
                        INSULATION - CELLULAR GLASS 2 IN,
                        C3 - 4 IN HW CONCRETE BLOCK,
                        BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN);
END;
    PROJECT= "DENTAL CLINIC - FT BRAGG NC";
    LOCATION = RALNC;
     GROUND TEMPERATURE = (59,60,61,62,66,70,74,72,69,66,64,61);
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    WEATHER TAPE FROM 01JAN THRU 31DEC;
BEGIN BUILDING DESCRIPTION;
      NORTH AXIS = 0.;
      DIMENSIONS: H = 9., N = 0, E = 90, S = 180, W = 270;
    SOLAR DISTRIBUTION = -1;
    ZONE 1 "ENTIRE BUILDING":
          ORIGIN: (0,0,0);
          EXTERIOR WALLS:
               FACING (S) EWALL1 (92 BY H)
                    WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW

                         (43.4 BY 4.25) AT (0,4)
                    WITH DOORS OF TYPE WINDOW PANEL
                         (26.6 BY 4) AT (0,0)
                    WITH OVERHANG (98 BY 3) AT (-3,H),
               FACING (E) EWALL1 (83.5 BY H)
                    WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                         (30.4 BY 4.25) AT (0,4)
                    WITH DOOR OF TYPE WINDOW PANEL
                         (19.95 BY 4) AT (0,0)
                    WITH OVERHANGS (108 BY 3) AT (-3,H),
               FACING (N) EWALL1 (45 BY H)
                    WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                         (13.3 BY 4.25) AT (0,4)
                    WITH DOOR OF TYPE WINDOW PANEL
                         (13.3 BY 4) AT (0,0)
                    WITH OVERHANG (98 BY 3) AT (-50,H),
               FACING (W) EWALL1 (102.5 BY H)
                    WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                         (30.44 BY 4.25) AT (0,4)
                    WITH DOOR OF TYPE WINDOW PANEL
                         (19.95 BY 4) AT (0,0)
                    WITH OVERHANG (108.5 BY 3) AT (-3,H);
          INTERNAL MASS: PWALL1 (9603 BY 1);
          INTERNAL MASS: PWALL2 (567 BY 1);
          FLOOR:
               FACING (E) FLOOR1 (8596.5 BY 1);
          ROOF:
               FACING (S) ROOF1 (8596.5 BY 1);
          PEOPLE = 85, ALL ZONES PEOPLE;

          LIGHTS = 49.04, CLINIC LIGHTS AND EQUIPMENT;
          ELECTRIC EQUIPMENT = 64.8, CLINIC LIGHTS AND EQUIPMENT;
          GAS EQUIPMENT = 5, CLINIC LIGHTS AND EQUIPMENT;
          CONTROLS = CLINIC CONTROLS, 45 HEATING, 601.3 COOLING;
END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM 1 "MAIN FAN SYSTEM" SERVING ZONES 1;
FOR ZONE 1:
      EXHAUST AIR VOLUME = 1600;
      SUPPLY AIR VOLUME = 12359;
END;
 EQUIPMENT SCHEDULES:
          SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
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        HEATING COIL OPERATION = OFF, FROM 01MAY THRU 25SEP;
 END;
OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .38;
      HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
      HOT DECK CONTROL SCHEDULE = (120 AT 10, 80 AT 70);
      COLD DECK CONTROL = FIXED SET POINT;
      COLD DECK TEMPERATURE = 60.;
    COLD DECK THROTTLING RANGE = 5;
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 4114.;
END;
COOLING COIL DESIGN PARAMETERS:
      COIL TYPE = DX;
      ENTERING AIR DRY BULB TEMPERATURE = 87.6;
      ENTERING AIR WET BULB TEMPERATURE = 70.3;
      LEAVING AIR DRY BULB TEMPERATURE = 61.;
      LEAVING AIR WET BULB TEMPERATURE = 59.;
      AIR FACE VELOCITY = 514.6;
      AIR VOLUME FLOW RATE = 15760;
      BAROMETRIC PRESSURE = 405;
      LEAVING REFRIGERANT TEMPERATURE=45.;
      ENTERING REFRIGERANT TEMPERATURE = 45;
      TOTAL COOLING LOAD = 600;
      NUMBER OF TUBE CIRCUITS=20;
END;
DX CONDENSING UNIT PARAMETERS:
      RPWRCD(.40349281,.21287191,.39339793);
      DESIGN SATURATED SUCTION TEMPERATURE=40;
      DESIGN SATURATED CONDENSING TEMPERATURE=130;
      DESIGN FULL LOAD POWER RATIO=.351;
      DX CONDENSING UNIT CAPACITY=600;
END DX CONDENSING UNIT PARAMETERS;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;
     PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
      EQUIPMENT SELECTION:
         1 BOILER OF SIZE 100;
      END EQUIPMENT SELECTION;
     END PLANT;
  END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

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**
**              INPUT FILE = DCNCF1I
**
**      THIS IS THE DENTAL CLINIC USED IN THE BLAST VALIDATION  (7/8/81)
**      STUDIES.   IT HAS BEEN SIMPLIFIED TO A ONE ZONE MODEL.
**      THE WALL/FLOOR/PEOPLE/ETC. HAVE ALL BEEN LUMPED TOGETHER.
**      THE FAN SYSTEM HAS NOT BEEN MODIFIED.  HOWEVER, THE CRAWL
**      SPACE HAS BEEN REMOVED.  THE BUILDING NOW HAS A SLAB ON
**      GRADE FLOOR.
**
**      THE SYSTEM OPERATION SCHEDULE WAS CHANGED FROM DEFAULT    (7/8/81)
**      TO "OFF" AND THE HEATING COIL SCHEDULE WAS CHANGED FROM
**      THAT FOR FT. HOOD TO THAT USED FOR RALEIGH, NC.
**
**      THE AMOUNT OF HEATING AND COOLING IS SET TO KEEP THE
**      BUILDING TEMPERATURE BETWEEN 66 AND 78F ALL YEAR.
**
BEGIN INPUT;
RUN CONTROL:  NEW ZONES,
              NEW AIR SYSTEMS,
           PLANT,
  UNITS(OUT=ENGLISH),
REPORTS(ZONE LOADS,SYSTEM,SYSTEM LOADS,COIL LOADS,PLANT LOADS, WALLS, ZONE);
      TEMPORARY LOCATION:
    RALNC = (LAT = 35.83, LONG = 78.83, TZ = 5);
      END;
      TEMPORARY DESIGN DAYS:
         RALNCSUM = (HIGH= 92, LOW= 71, WB= 75, DATE= 21JUL,
                     PRES= 405, WS= 440, DIR= 270,

                     CLEARNESS= 1, WEEKDAY);
         RALNCWIN = (HIGH= 29, LOW= 14, WB= 10, DATE= 21JAN,
                     PRES= 405, WS= 1320, DIR= 325,
                     CLEARNESS= .1, WEEKEND);
      END;
  TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - OFF),
     HOLIDAY = SUNDAY;
  END;
TEMPORARY SCHEDULE (ALL ZONES PEOPLE):
      MONDAY THRU FRIDAY = (17 TO 07 - 0.,.5,.94,.92,.79,.52,.56,.75,
                                  .68,.61,.28),
      SATURDAY THRU SUNDAY = (00 TO 24 - 0),
      HOLIDAY = SUNDAY;
END;
TEMPORARY SCHEDULE (CLINIC LIGHTS AND EQUIPMENT):
 MONDAY THRU FRIDAY = (19 TO 07 - .34,.58,.98,.98,.98,.86,
                        .72,.91,.98,.95,.79,.40,.40),
      SATURDAY THRU SUNDAY = (00 TO 24 - .34),
      HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (CLINIC CONTROLS):
      PROFILES:
        CONSTANT = (1 AT 66, 0 AT 68, -.125 AT 70, -1 AT 140);
```

```
          SCHEDULES:
             MONDAY THRU SUNDAY = (00 TO 24 - CONSTANT),
             HOLIDAY = SUNDAY;
    END;
    TEMPORARY WALLS:
          EWALL1 = (BRICK - FACE 4 IN,
                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    CONCRETE - CEMENT MORTAR 1/2 IN,
                    C3 - 4 IN HW CONCRETE BLOCK,
                    B1 - AIRSPACE RESISTANCE,
                    BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
          PWALL1 = (BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN,
                    B1 - AIRSPACE RESISTANCE,
                    BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
          PWALL2 = (C8 - 8 IN HW CONCRETE BLOCK,
                    B1 - AIRSPACE RESISTANCE,
                    BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
          CPWALL = (A1 - 1 IN STUCCO,
                    C10 - 8 IN HW CONCRETE,
                    E1 - 3 / 4 IN PLASTER OR GYP BOARD);
    END;
    TEMPORARY ROOFS:
          ROOF1 = (E2 - 1/ 2 IN SLAG OR STONE,
                   E3 - 3/8 IN FELT AND MEMBRANE,
                   A3 - STEEL SIDING,
                   E4 - CEILING AIRSPACE,
                   B4 - 3 IN INSULATION,
                   E5 - ACOUSTIC TILE),
          CPCEIL =(FINISH FLOURING - TILE 1/16 IN,
                   C10 - 8 IN HW CONCRETE,
                   B1 - AIRSPACE RESISTANCE,
                   B2 - 1 IN INSULATION);
    END;
    TEMPORARY FLOORS:
          FLOOR1 = (B2 - 1 IN INSULATION,
                    B1 - AIRSPACE RESISTANCE,
                    C10 - 8 IN HW CONCRETE,
                    FINISH FLOORING - TILE 1/16 IN),
          CPFLOUR = (DIRT 12 IN);
    END;
    TEMPORARY DOORS:
          WINDOW PANEL = (GLASS - HEAT ABSORBING PLATE 1/ 2 IN,
                          INSULATION - CELLULAR GLASS 2 IN,
                          C3 - 4 IN HW CONCRETE BLOCK,
                          BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN);
    END;
       PROJECT= "DENTAL CLINIC - FT BRAGG NC";
       LOCATION = RALNC;
        GROUND TEMPERATURE = (59,60,61,62,66,70,74,72,69,66,64,61);
        WEATHER TAPE FROM 01JAN THRU 31DEC;
    BEGIN BUILDING DESCRIPTION;
```

```
          NORTH AXIS = 0.;
          DIMENSIONS: H = 9., N = 0, E = 90, S = 180, W = 270;
        SOLAR DISTRIBUTION = -1;
        ZONE 1 "ENTIRE BUILDING":
             ORIGIN: (0,0,0);
             EXTERIOR WALLS:
                  FACING (S) EWALL1 (92 BY H)
                       WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                            (43.4 BY 4.25) AT (0,4)
                       WITH DOORS OF TYPE WINDOW PANEL

                            (26.6 BY 4) AT (0,0)
                       WITH OVERHANG (98 BY 3) AT (-3,H),
                  FACING (E) EWALL1 (83.5 BY H)
                       WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                            (30.4 BY 4.25) AT (0,4)
                       WITH DOOR OF TYPE WINDOW PANEL
                            (19.95 BY 4) AT (0,0)
                       WITH OVERHANGS (108 BY 3) AT (-3,H),
                  FACING (N) EWALL1 (45 BY H)
                       WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                            (13.3 BY 4.25) AT (0,4)
                       WITH DOOR OF TYPE WINDOW PANEL
                            (13.3 BY 4) AT (0,0)
                       WITH OVERHANG (98 BY 3) AT (-50,H),
                  FACING (W) EWALL1 (102.5 BY H)
                       WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                            (30.44 BY 4.25) AT (0,4)
                       WITH DOOR OF TYPE WINDOW PANEL
                            (19.95 BY 4) AT (0,0)
                       WITH OVERHANG (108.5 BY 3) AT (-3,H);
             INTERNAL MASS: PWALL1 (9603 BY 1);
             INTERNAL MASS: PWALL2 (567 BY 1);
             SLAB ON GRADE FLOOR:
                  FACING (E) FLOOR1 (92.72 BY 92.72);
             ROOF:
                  FACING (S) ROOF1 (92.72 BY 92.72);
             PEOPLE = 85, ALL ZONES PEOPLE;
             LIGHTS = 49.04, CLINIC LIGHTS AND EQUIPMENT;
             ELECTRIC EQUIPMENT = 64.8, CLINIC LIGHTS AND EQUIPMENT;

             GAS EQUIPMENT = 5, CLINIC LIGHTS AND EQUIPMENT;
             CONTROLS = CLINIC CONTROLS, 45 HEATING, 601.3 COOLING;
END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM 1 "MAIN FAN SYSTEM" SERVING ZONES 1;
FOR ZONE 1:
      EXHAUST AIR VOLUME = 1600;
      SUPPLY AIR VOLUME = 12359;
END;
 EQUIPMENT SCHEDULES:
             SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
             HEATING COIL OPERATION = OFF, FROM 01MAY THRU 25SEP;
 END;
```

```
OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .38;
      HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
      HOT DECK CONTROL SCHEDULE = (120 AT 10, 80 AT 70);
      COLD DECK CONTROL = FIXED SET POINT;
      COLD DECK TEMPERATURE = 60.;
    COLD DECK THROTTLING RANGE = 5;
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 4114.;
END;
COOLING COIL DESIGN PARAMETERS:
      COIL TYPE = DX;
      ENTERING AIR DRY BULB TEMPERATURE = 87.6;
      ENTERING AIR WET BULB TEMPERATURE = 70.3;
      LEAVING AIR DRY BULB TEMPERATURE = 61.;

      LEAVING AIR WET BULB TEMPERATURE = 59.;
      AIR FACE VELOCITY = 514.6;
      AIR VOLUME FLOW RATE = 15760;
      BAROMETRIC PRESSURE = 405;
      LEAVING REFRIGERANT TEMPERATURE=45.;
      ENTERING REFRIGERANT TEMPERATURE = 45;
      TOTAL COOLING LOAD = 600;
      NUMBER OF TUBE CIRCUITS=20;
END;
DX CONDENSING UNIT PARAMETERS:
      RPWRCO(.40349281,.21287191,.39339793);
      DESIGN SATURATED SUCTION TEMPERATURE=40;
      DESIGN SATURATED CONDENSING TEMPERATURE=130;
      DESIGN FULL LOAD POWER RATIO=.351;
      DX CONDENSING UNIT CAPACITY=600;
END DX CONDENSING UNIT PARAMETERS;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;
     PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
      EQUIPMENT SELECTION:
         1 BOILER OF SIZE 100;
      END EQUIPMENT SELECTION;
     END PLANT;
  END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

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**
**                INPUT FILE = DCNCF2I
**
**       THIS IS THE DENTAL CLINIC USED IN THE BLAST VALIDATION  (7/10/81)
**       STUDIES.   IT HAS BEEN SIMPLIFIED TO A TWO ZONE MODEL.
**       THE WALL/FLOOR/PEOPLE/ETC. HAVE ALL BEEN LUMPED TOGETHER.
**       THE FAN SYSTEM HAS NOT BEEN MODIFIED.  HOWEVER, THE CRAWL
**       SPACE HAS BEEN REMOVED.  THE BUILDING NOW HAS A SLAB ON
**       GRADE FLOOR.
**
**       THE SYSTEM OPERATION SCHEDULE WAS CHANGED FROM DEFAULT    (7/8/81)
**       TO "OFF" AND THE HEATING COIL SCHEDULE WAS CHANGED FROM
**       THAT FOR FT. HOOD TO THAT USED FOR RALEIGH, NC.
**
**       THE AMOUNT OF HEATING AND COOLING IS SET TO KEEP THE
**       BUILDING TEMPERATURE BETWEEN 66 AND 78F ALL YEAR.
**
BEGIN INPUT;
RUN CONTROL:  NEW ZONES,
              NEW AIR SYSTEMS,
           PLANT,
  UNITS(OUT=ENGLISH),
REPORTS(ZONE LOADS,SYSTEM,SYSTEM LOADS,COIL LOADS,PLANT LOADS, WALLS, ZONE);
      TEMPORARY LOCATION:
    RALNC = (LAT = 35.83, LONG = 78.83, TZ = 5);
      END;
      TEMPORARY DESIGN DAYS:
         RALNCSUM = (HIGH= 92, LOW= 71, WB= 75, DATE= 21JUL,
                     PRES= 405, WS= 440, DIR= 270,

                     CLEARNESS= 1, WEEKDAY);
         RALNCWIN = (HIGH= 29, LOW= 14, WB= 10, DATE= 21JAN,
                     PRES= 405, WS= 1320, DIR= 325,
                     CLEARNESS= .1, WEEKEND);
      END;
  TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - OFF),
     HOLIDAY = SUNDAY;
  END;
TEMPORARY SCHEDULE (ALL ZONES PEOPLE):
      MONDAY THRU FRIDAY = (17 TO 07 - 0.,.5,.94,.92,.79,.52,.56,.75,
                              .68,.61,.28),
      SATURDAY THRU SUNDAY = (00 TO 24 - 0),
      HOLIDAY = SUNDAY;
END;
TEMPORARY SCHEDULE (CLINIC LIGHTS AND EQUIPMENT):
 MONDAY THRU FRIDAY = (19 TO 07 - .34,.58,.98,.98,.98,.86,
                         .72,.91,.98,.95,.79,.40,.40),
      SATURDAY THRU SUNDAY = (00 TO 24 - .34),
      HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (CLINIC CONTROLS):
      PROFILES:
        CONSTANT = (1 AT 66, 0 AT 68, -.125 AT 70, -1 AT 140);
```

```
        SCHEDULES:
           MONDAY THRU SUNDAY = (00 TO 24 - CONSTANT),
           HOLIDAY = SUNDAY;
  END;
  TEMPORARY WALLS:
        EWALL1 = (BRICK - FACE 4 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  CONCRETE - CEMENT MORTAR 1/2 IN,
                  C3 - 4 IN HW CONCRETE BLOCK,
                  B1 - AIRSPACE RESISTANCE,
                  BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
        PWALL1 = (BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN,
                  B1 - AIRSPACE RESISTANCE,
                  BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
        PWALL2 = (C8 - 8 IN HW CONCRETE BLOCK,
                  B1 - AIRSPACE RESISTANCE,
                  BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
        CPWALL = (A1 - 1 IN STUCCO,
                  C10 - 8 IN HW CONCRETE,
                  E1 - 3 / 4 IN PLASTER OR GYP BOARD);
  END;
  TEMPORARY ROOFS:
        ROOF1 = (E2 - 1/ 2 IN SLAG OR STONE,
                 E3 - 3/8 IN FELT AND MEMBRANE,
                 A3 - STEEL SIDING,
                 E4 - CEILING AIRSPACE,
                 B4 - 3 IN INSULATION,
                 E5 - ACOUSTIC TILE),
        CPCEIL =(FINISH FLOORING - TILE 1/16 IN,
                 C10 - 8 IN HW CONCRETE,
                 B1 - AIRSPACE RESISTANCE,
                 B2 - 1 IN INSULATION);
  END;
  TEMPORARY FLOORS:
        FLOOR1 = (B2 - 1 IN INSULATION,
                  B1 - AIRSPACE RESISTANCE,
                  C10 - 8 IN HW CONCRETE,
                  FINISH FLOORING - TILE 1/16 IN),
        CPFLOOR = (DIRT 12 IN);
  END;
  TEMPORARY DOORS:
        WINDOW PANEL = (GLASS - HEAT ABSORBING PLATE 1/ 2 IN,
                        INSULATION - CELLULAR GLASS 2 IN,
                        C3 - 4 IN HW CONCRETE BLOCK,
                        BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN);
  END;
     PROJECT= "DENTAL CLINIC - FT BRAGG NC";
     LOCATION = RALNC;
      GROUND TEMPERATURE = (59,60,61,62,66,70,74,72,69,66,64,61);
      WEATHER TAPE FROM 01JAN THRU 31DEC;
  BEGIN BUILDING DESCRIPTION;
```

```
  NORTH AXIS = 0.;
  DIMENSIONS: H = 9., N = 0, E = 90, S = 180, W = 270;
SOLAR DISTRIBUTION = -1;
ZONE 1 "ENTIRE BUILDING - XRAY ROOM":
     ORIGIN: (0,0,0);
     EXTERIOR WALLS:
          FACING (S) EWALL1 (92 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (43.4 BY 4.25) AT (0,4)
               WITH DOORS OF TYPE WINDOW PANEL

                    (26.6 BY 4) AT (0,0)
               WITH OVERHANG (98 BY 3) AT (-3,H),
          FACING (E) EWALL1 (83.5 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (30.4 BY 4.25) AT (0,4)
               WITH DOOR OF TYPE WINDOW PANEL
                    (19.95 BY 4) AT (0,0)
               WITH OVERHANGS (108 BY 3) AT (-3,H),
          FACING (N) EWALL1 (45 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (13.3 BY 4.25) AT (0,4)
               WITH DOOR OF TYPE WINDOW PANEL
                    (13.3 BY 4) AT (0,0)
               WITH OVERHANG (98 BY 3) AT (-50,H),
          FACING (W) EWALL1 (102.5 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (30.44 BY 4.25) AT (0,4)
               WITH DOOR OF TYPE WINDOW PANEL
                    (19.95 BY 4) AT (0,0)
               WITH OVERHANG (108.5 BY 3) AT (-3,H);
     INTERNAL MASS: PWALL1 (8199 BY 1);
     INTERNAL MASS: PWALL2 (531 BY 1);
     SLAB ON GRADE FLOOR:
          FACING (E) FLOOR1 (87.31 BY 87.31);
     ROOF:
          FACING (S) ROOF1 (87.31 BY 87.31);
     PEOPLE = 80, ALL ZONES PEOPLE;
     LIGHTS = 45.08, CLINIC LIGHTS AND EQUIPMENT;
     ELECTRIC EQUIPMENT = 35.93, CLINIC LIGHTS AND EQUIPMENT;

     GAS EQUIPMENT = 5, CLINIC LIGHTS AND EQUIPMENT;
     CONTROLS = CLINIC CONTROLS, 45 HEATING, 452.3 COOLING;
END ZONE;
    ZONE A "X-RAY":
     ORIGIN: (0,0,0);
     INTERNAL MASS: PWALL1 (1404 BY 1);
     INTERNAL MASS: PWALL2 (36 BY 1);
     SLAB ON GRADE FLOOR:
          FACING (E) FLOOR1 (31.21 BY 31.21);
     ROOF:
          FACING (S) ROOF1 (31.21 BY 31.21);
     PEOPLE = 5, ALL ZONES PEOPLE;
     LIGHTS = 3.96, CLINIC LIGHTS AND EQUIPMENT;
     ELECTRIC EQUIPMENT = 28.87, CLINIC LIGHTS AND EQUIPMENT;
```

```
        CONTROLS = CLINIC CONTROLS, 0 HEATING, 149 COOLING;
    END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM 1 "MAIN FAN SYSTEM" SERVING ZONES 1,8;
FOR ZONE 1:
      EXHAUST AIR VOLUME = 1600;
      SUPPLY AIR VOLUME = 11530;
END;
    FOR ZONE 8:
         SUPPLY AIR VOLUME = 829;
    END;
 EQUIPMENT SCHEDULES:
         SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
         HEATING COIL OPERATION = OFF, FROM 01MAY THRU 25SEP;

 END;
OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .38;
      HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
      HOT DECK CONTROL SCHEDULE = (120 AT 10, 80 AT 70);
      COLD DECK CONTROL = FIXED SET POINT;
      COLD DECK TEMPERATURE = 60.;
    COLD DECK THROTTLING RANGE = 5;
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 4114.;
END;
COOLING COIL DESIGN PARAMETERS:
      COIL TYPE = DX;
      ENTERING AIR DRY BULB TEMPERATURE = 87.6;
      ENTERING AIR WET BULB TEMPERATURE = 70.3;
      LEAVING AIR DRY BULB TEMPERATURE = 61.;
      LEAVING AIR WET BULB TEMPERATURE = 59.;
      AIR FACE VELOCITY = 514.6;
      AIR VOLUME FLOW RATE = 15760;
      BAROMETRIC PRESSURE = 405;
      LEAVING REFRIGERANT TEMPERATURE=45.;
      ENTERING REFRIGERANT TEMPERATURE = 45;
      TOTAL COOLING LOAD = 600;
      NUMBER OF TUBE CIRCUITS=20;
END;
DX CONDENSING UNIT PARAMETERS:
      RPWFCU(.40349281,.21287191,.39339793);
      DESIGN SATURATED SUCTION TEMPERATURE=40;
      DESIGN SATURATED CONDENSING TEMPERATURE=130;
      DESIGN FULL LOAD POWER RATIO=.351;
      DX CONDENSING UNIT CAPACITY=600;
END DX CONDENSING UNIT PARAMETERS;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;
     PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
      EQUIPMENT SELECTION:
         1 BOILER OF SIZE 100;
```

```
      END EQUIPMENT SELECTION;
     END PLANT;
  END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

```
**
**                INPUT FILE = DCNCF3I
**
**      THIS IS THE DENTAL CLINIC USED IN THE BLAST VALIDATION  (7/14/81)
**      STUDIES.   IT HAS BEEN SIMPLIFIED TO A THREE ZONE MODEL.
**      THE WALL/FLOOR/PEOPLE/ETC. HAVE ALL BEEN LUMPED TOGETHER.
**      THE FAN SYSTEM HAS NOT BEEN MODIFIED.  HOWEVER, THE CRAWL
**      SPACE HAS BEEN REMOVED.  THE BUILDING NOW HAS A SLAB ON
**      GRADE FLOOR.
**
**      THE SYSTEM OPERATION SCHEDULE WAS CHANGED FROM DEFAULT     (7/8/81)
**      TO "OFF" AND THE HEATING COIL SCHEDULE WAS CHANGED FROM
**      THAT FOR FT. HOOD TO THAT USED FOR RALEIGH, NC.
**
**      THE AMOUNT OF HEATING AND COOLING IS SET TO KEEP THE
**      BUILDING TEMPERATURE BETWEEN 66 AND 78F ALL YEAR.
**
BEGIN INPUT;
RUN CONTROL:  NEW ZONES,
              NEW AIR SYSTEMS,
          PLANT,
  UNITS(OUT=ENGLISH),
REPORTS(ZONE LOADS,SYSTEM,SYSTEM LOADS,COIL LOADS,PLANT LOADS, WALLS, ZONE);
      TEMPORARY LOCATION:
    RALNC = (LAT = 35.83, LONG = 78.83, TZ = 5);
      END;
      TEMPORARY DESIGN DAYS:
         RALNCSUM = (HIGH= 92, LOW= 71, WB= 75, DATE= 21JUL,
                     PRES= 405, WS= 440, DIR= 270,

                     CLEARNESS= 1, WEEKDAY);
         RALNCWIN = (HIGH= 29, LOW= 14, WB= 10, DATE= 21JAN,
                     PRES= 405, WS= 1320, DIR= 325,
                     CLEARNESS= .1, WEEKEND);
      END;
  TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - OFF),
    HOLIDAY = SUNDAY;
  END;
TEMPORARY SCHEDULE (ALL ZONES PEOPLE):
      MONDAY THRU FRIDAY = (17 TO 07 - 0.,.5,.94,.92,.79,.52,.50,.75,
                            .68,.61,.28),
      SATURDAY THRU SUNDAY = (00 TO 24 - 0),
      HOLIDAY = SUNDAY;
END;
TEMPORARY SCHEDULE (CLINIC LIGHTS AND EQUIPMENT):
 MONDAY THRU FRIDAY = (19 TO 07 - .34,.58,.98,.98,.98,.86,
                       .72,.91,.98,.95,.79,.40,.40),
      SATURDAY THRU SUNDAY = (00 TO 24 - .34),
      HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (CLINIC CONTROLS):
      PROFILES:
        CONSTANT = (1 AT 66, 0 AT 68, -.125 AT 70, -1 AT 140);
```

AD-A131 261 USE OF SIMPLIFIED INPUT FOR BLAST ENERGY ANALYSIS(U) 2/2
CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN
IL D HERRON ET AL. MAY 83 CERL-TR-E-185

UNCLASSIFIED F/G 13/13 NL

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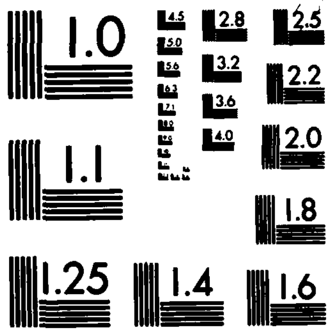

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
      SCHEDULES:
         MONDAY THRU SUNDAY = (00 TO 24 - CONSTANT),
         HOLIDAY = SUNDAY;
END;
TEMPORARY WALLS:
      EWALL1 = (BRICK - FACE 4 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                C3 - 4 IN HW CONCRETE BLOCK,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL1 = (BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL2 = (C8 - 8 IN HW CONCRETE BLOCK,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      CPWALL = (A1 - 1 IN STUCCO,
                C10 - 8 IN HW CONCRETE,
                E1 - 3 / 4 IN PLASTER OR GYP BOARD);
END;
TEMPORARY ROOFS:
      ROOF1 = (E2 - 1/ 2 IN SLAG OR STONE,
               E3 - 3/8 IN FELT AND MEMBRANE,
               A3 - STEEL SIDING,
               E4 - CEILING AIRSPACE,
               B4 - 3 IN INSULATION,
               E5 - ACOUSTIC TILE),
      CPCEIL =(FINISH FLOORING - TILE 1/16 IN,
               C10 - 8 IN HW CONCRETE,
               B1 - AIRSPACE RESISTANCE,
               B2 - 1 IN INSULATION));
END;
TEMPORARY FLOORS:
      FLOOR1 = (B2 - 1 IN INSULATION,
                B1 - AIRSPACE RESISTANCE,
                C10 - 8 IN HW CONCRETE,
                FINISH FLOORING - TILE 1/16 IN),
      CPFLOOR = (DIRT 12 IN);
END;
TEMPORARY DOORS:
      WINDOW PANEL = (GLASS - HEAT ABSORBING PLATE 1/ 2 IN,
                      INSULATION - CELLULAR GLASS 2 IN,
                      C3 - 4 IN HW CONCRETE BLOCK,
                      BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN);
END;
   PROJECT= "DENTAL CLINIC - FT BRAGG NC";
   LOCATION = RALNC;
    GROUND TEMPERATURE = (59,60,61,62,66,70,74,72,69,66,64,61);
    WEATHER TAPE FROM 01JAN THRU 31DEC;
BEGIN BUILDING DESCRIPTION;
```

```
NORTH AXIS = 0.;
DIMENSIONS: H = 9., N = 0, E = 90, S = 180, W = 270;
SOLAR DISTRIBUTION = -1;
ZONE 1 "EXTERIOR ZONES (1,2,3,9,10)":
     ORIGIN: (0,0,0);
     EXTERIOR WALLS:
          FACING (S) EWALL1 (92 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (43.4 BY 4.25) AT (0,4)
               WITH DOORS OF TYPE WINDOW PANEL

                    (26.6 BY 4) AT (0,0)
               WITH OVERHANG (98 BY 3) AT (-3,H),
          FACING (E) EWALL1 (83.5 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (30.4 BY 4.25) AT (0,4)
               WITH DOOR OF TYPE WINDOW PANEL
                    (19.95 BY 4) AT (0,0)
               WITH OVERHANGS (108 BY 3) AT (-3,H),
          FACING (N) EWALL1 (45 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (13.3 BY 4.25) AT (0,4)
               WITH DOOR OF TYPE WINDOW PANEL
                    (13.3 BY 4) AT (0,0)
               WITH OVERHANG (98 BY 3) AT (-50,H),
          FACING (W) EWALL1 (102.5 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (30.44 BY 4.25) AT (0,4)
               WITH DOOR OF TYPE WINDOW PANEL
                    (19.95 BY 4) AT (0,0)
               WITH OVERHANG (108.5 BY 3) AT (-3,H);
     INTERNAL MASS: PWALL1 (3109.5 BY 1);
     INTERNAL MASS: PWALL2 (306 BY 1);
     SLAB ON GRADE FLOOR:
          FACING (E) FLOOR1 (66.91 BY 66.91);
     ROOF:
          FACING (S) ROOF1 (66.91 BY 66.91);
     PEOPLE = 36, ALL ZONES PEOPLE;
     LIGHTS = 30.74, CLINIC LIGHTS AND EQUIPMENT;
     ELECTRIC EQUIPMENT = 27.29, CLINIC LIGHTS AND EQUIPMENT;

     GAS EQUIPMENT = 5, CLINIC LIGHTS AND EQUIPMENT;
     CONTROLS = CLINIC CONTROLS, 30 HEATING, 347.5 COOLING;
END ZONE;
**
  ZONE 2 "INTERIOR (ZONES 4,5,6,7)":
     ORIGIN: (0,0,0);
          INTERNAL MASS: PWALL1 (5089.5 BY 1);
          INTERNAL MASS: PWALL2 (225 BY 1);
     SLAB ON GRADE FLOOR:
          FACING (E) FLOOR1 (56.08 BY 56.08);
     ROOF:
          FACING (S) ROOF1 (56.08 BY 56.08);
     PEOPLE = 44, ALL ZONES PEOPLE;
     LIGHTS = 14.34, CLINIC LIGHTS AND EQUIPMENT;
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        ELECTRIC EQUIPMENT = 8.64, CLINIC LIGHTS AND EQUIPMENT;
        CONTROLS = CLINIC CONTROLS, 15 HEATING, 104.8 COOLING;
    END ZONE;
    ZONE 8 "X-RAY":
        ORIGIN: (0,0,0);
        INTERNAL MASS: PWALL1 (1404 BY 1);
        INTERNAL MASS: PWALL2 (36 BY 1);
        SLAB ON GRADE FLOOR:
            FACING (E) FLOOR1 (31.21 BY 31.21);
        ROOF:
            FACING (S) ROOF1 (31.21 BY 31.21);
        PEOPLE = 5, ALL ZONES PEOPLE;
        LIGHTS = 3.96, CLINIC LIGHTS AND EQUIPMENT;
        ELECTRIC EQUIPMENT = 28.87, CLINIC LIGHTS AND EQUIPMENT;
        CONTROLS = CLINIC CONTROLS, 0 HEATING, 149 COOLING;

    END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM 1 "MAIN FAN SYSTEM" SERVING ZONES 1,2,8;
FOR ZONE 1:
      EXHAUST AIR VOLUME = 1000;
      SUPPLY AIR VOLUME = 8550;
END;
    FOR ZONE 2:
        EXHAUST AIR VOLUME = 600;
        SUPPLY AIR VOLUME = 2980;
    END ZONE;
    FOR ZONE 8:
        SUPPLY AIR VOLUME = 829;
    END;
 EQUIPMENT SCHEDULES:
        SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
        HEATING COIL OPERATION = OFF, FROM 01MAY THRU 25SEP;
 END;
OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .38;
      HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
      HOT DECK CONTROL SCHEDULE = (120 AT 10, 80 AT 70);
      COLD DECK CONTROL = FIXED SET POINT;
      COLD DECK TEMPERATURE = 60.;
    COLD DECK THROTTLING RANGE = 5;
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 4114.;
END;

COOLING COIL DESIGN PARAMETERS:
      COIL TYPE = DX;
      ENTERING AIR DRY BULB TEMPERATURE = 87.6;
      ENTERING AIR WET BULB TEMPERATURE = 70.3;
      LEAVING AIR DRY BULB TEMPERATURE = 61.;
      LEAVING AIR WET BULB TEMPERATURE = 59.;
      AIR FACE VELOCITY = 514.6;
      AIR VOLUME FLOW RATE = 15760;
      BAROMETRIC PRESSURE = 405;
```

```
      LEAVING REFRIGERANT TEMPERATURE=45.;
      ENTERING REFRIGERANT TEMPERATURE = 45;
      TOTAL COOLING LOAD = 600;
      NUMBER OF TUBE CIRCUITS=20;
END;
DX CONDENSING UNIT PARAMETERS:
      RPWRCD(.40349281,.21287191,.39339793);
      DESIGN SATURATED SUCTION TEMPERATURE=40;
      DESIGN SATURATED CONDENSING TEMPERATURE=130;
      DESIGN FULL LOAD POWER RATIO=.351;
      DX CONDENSING UNIT CAPACITY=600;
END DX CONDENSING UNIT PARAMETERS;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;
     PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
      EQUIPMENT SELECTION:
         1 BOILER OF SIZE 100;
      END EQUIPMENT SELECTION;
     END PLANT;

  END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

```
**
**                INPUT FILE = DCNCF4I
**
**       THIS IS THE DENTAL CLINIC USED IN THE BLAST VALIDATION  (7/14/81)
**       STUDIES.   IT HAS BEEN SIMPLIFIED TO A FOUR ZONE MODEL.
**       THE WALL/FLOOR/PEOPLE/ETC. HAVE ALL BEEN LUMPED TOGETHER.
**       THE FAN SYSTEM HAS NOT BEEN MODIFIED.  HOWEVER, THE CRAWL
**       SPACE HAS BEEN REMOVED.  THE BUILDING NOW HAS A SLAB ON
**       GRADE FLOOR.
**
**       THE SYSTEM OPERATION SCHEDULE WAS CHANGED FROM DEFAULT     (7/8/81)
**       TO "OFF" AND THE HEATING COIL SCHEDULE WAS CHANGED FROM
**       THAT FOR FT. HOOD TO THAT USED FOR RALEIGH, NC.
**
**       THE AMOUNT OF HEATING AND COOLING IS SET TO KEEP THE
**       BUILDING TEMPERATURE BETWEEN 66 AND 78F ALL YEAR.
**
BEGIN INPUT;
RUN CONTROL:  NEW ZONES,
              NEW AIR SYSTEMS,
           PLANT,
  UNITS(OUT=ENGLISH),
REPORTS(ZONE LOADS,SYSTEM,SYSTEM LOADS,COIL LOADS,PLANT LOADS, WALLS, ZONE);
      TEMPORARY LOCATION:
    RALNC = (LAT = 35.83, LONG = 78.83, TZ = 5);
      END;
      TEMPORARY DESIGN DAYS:
         RALNCSUM = (HIGH= 92, LOW= 71, WB= 75, DATE= 21JUL,
                     PRES= 405, WS= 440, DIR= 270,

                     CLEARNESS= 1, WEEKDAY);
         RALNCWIN = (HIGH= 29, LOW= 14, WB= 10, DATE= 21JAN,
                     PRES= 405, WS= 1320, DIR= 325,
                     CLEARNESS= .1, WEEKEND);
      END;
  TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - OFF),
     HOLIDAY = SUNDAY;
  END;
TEMPORARY SCHEDULE (ALL ZONES PEOPLE):
      MONDAY THRU FRIDAY = (17 TO 07 - 0.,.5,.94,.92,.79,.52,.56,.75,
                                 .68,.61,.28),
      SATURDAY THRU SUNDAY = (00 TO 24 - 0),
      HOLIDAY = SUNDAY;
END;
TEMPORARY SCHEDULE (CLINIC LIGHTS AND EQUIPMENT):
 MONDAY THRU FRIDAY = (19 TO 07 - .34,.58,.98,.98,.98,.86,
                            .72,.91,.98,.95,.79,.40,.40),
      SATURDAY THRU SUNDAY = (00 TO 24 - .34),
      HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (CLINIC CONTROLS):
      PROFILES:
        CONSTANT = (1 AT 66, 0 AT 68, -.125 AT 70, -1 AT 140);
```

```
      SCHEDULES:
         MONDAY THRU SUNDAY = (00 TO 24 - CONSTANT),
         HOLIDAY = SUNDAY;
END;
TEMPORARY WALLS:
      EWALL1 = (BRICK - FACE 4 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                C3 - 4 IN HW CONCRETE BLOCK,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL1 = (BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL2 = (C8 - 8 IN HW CONCRETE BLOCK,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      CPWALL = (A1 - 1 IN STUCCO,
                C10 - 8 IN HW CONCRETE,
                E1 - 3 / 4 IN PLASTER OR GYP BOARD);
END;
TEMPORARY ROOFS:
      ROOF1 = (E2 - 1/ 2 IN SLAG OR STONE,
               E3 - 3/8 IN FELT AND MEMBRANE,
               A3 - STEEL SIDING,
               E4 - CEILING AIRSPACE,
               B4 - 3 IN INSULATION,
               E5 - ACOUSTIC TILE),
      CPCEIL =(FINISH FLOORING - TILE 1/16 IN,
               C10 - 8 IN HW CONCRETE,
               B1 - AIRSPACE RESISTANCE,
               B2 - 1 IN INSULATION);
END;
TEMPORARY FLOORS:
      FLOOR1 = (B2 - 1 IN INSULATION,
                B1 - AIRSPACE RESISTANCE,
                C10 - 8 IN HW CONCRETE,
                FINISH FLOORING - TILE 1/16 IN),
      CPFLOOR = (DIRT 12 IN);
END;
TEMPORARY DOORS:
      WINDOW PANEL = (GLASS - HEAT ABSORBING PLATE 1/ 2 IN,
                      INSULATION - CELLULAR GLASS 2 IN,
                      C3 - 4 IN HW CONCRETE BLOCK,
                      BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN);
END;
   PROJECT= "DENTAL CLINIC - FT BRAGG NC";
   LOCATION = RALNC;
    GROUND TEMPERATURE = (59,60,61,62,66,70,74,72,69,66,64,61);
    WEATHER TAPE FROM 01JAN THRU 31DEC;
BEGIN BUILDING DESCRIPTION;
```

```
   NORTH AXIS = 0.;
   DIMENSIONS: H = 9., N = 0, E = 90, S = 180, W = 270;
  SOLAR DISTRIBUTION = -1;
**
  ZONE 1 "NORTH EXTERIOR ZONES (1,2)":
       ORIGIN: (0,0,0);
       EXTERIOR WALLS:
            FACING (N) EWALL1 (45 BY H)
                 WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                      (13.3 BY 4.25) AT (0,4)
                 WITH DOOR OF TYPE WINDOW PANEL
                      (13.3 BY 4) AT (0,0)
                 WITH OVERHANG (98 BY 3) AT (-50,H),
            FACING (W) EWALL1 (19 BY H)
                 WITH OVERHANG (108 BY 3) AT (-3,H);
       INTERNAL MASS: PWALL1 (643.5 BY 1);
       INTERNAL MASS: PWALL2 (171 BY 1);
       SLAB ON GRADE FLOOR:
            FACING (E) FLOOR1 (855 BY 1);
       ROOF:
            FACING (S) ROOF1 (855 BY 1);
       PEOPLE = 6, ALL ZONES PEOPLE;
       LIGHTS = 7.91, CLINIC LIGHTS AND EQUIPMENT;
       ELECTRIC EQUIPMENT = 17.06, CLINIC LIGHTS AND EQUIPMENT;
       GAS EQUIPMENT = 5, CLINIC LIGHTS AND EQUIPMENT;
       CONTROLS = CLINIC CONTROLS, 0 HEATING, 140.4 COOLING;
   END ZONE;
  ZONE 2 "EXTERIOR ZONES (3,9,10)":
       ORIGIN: (0,0,0);
       EXTERIOR WALLS:
            FACING (S) EWALL1 (92 BY H)
                 WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                      (43.4 BY 4.25) AT (0,4)
                 WITH DOORS OF TYPE WINDOW PANEL
                      (26.6 BY 4) AT (0,0)
                 WITH OVERHANG (98 BY 3) AT (-3,H),
            FACING (E) EWALL1 (83.5 BY H)
                 WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                      (30.4 BY 4.25) AT (0,4)
                 WITH DOOR OF TYPE WINDOW PANEL
                      (19.95 BY 4) AT (0,0)
                 WITH OVERHANGS (108 BY 3) AT (-3,H),
            FACING (W) EWALL1 (83.5 BY H)
                 WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                      (30.44 BY 4.25) AT (0,4)
                 WITH DOOR OF TYPE WINDOW PANEL
                      (19.95 BY 4) AT (0,0)
                 WITH OVERHANG (108.5 BY 3) AT (-3,H);
       INTERNAL MASS: PWALL1 (2466 BY 1);
       INTERNAL MASS: PWALL2 (135 BY 1);
       SLAB ON GRADE FLOOR:
            FACING (E) FLOOR1 (3622 BY 1);
       ROOF:
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                FACING (S) ROOF1 (3622 BY 1);
          PEOPLE = 30, ALL ZONES PEOPLE;
          LIGHTS = 22.83, CLINIC LIGHTS AND EQUIPMENT;
          ELECTRIC EQUIPMENT = 10.23, CLINIC LIGHTS AND EQUIPMENT;
          CONTROLS = CLINIC CONTROLS, 30 HEATING, 207.1 COOLING;
END ZONE;
**
     ZONE 3 "INTERIOR (ZONES 4,5,6,7)":
          ORIGIN: (0,0,0);
                INTERNAL MASS: PWALL1 (5089.5 BY 1);
                INTERNAL MASS: PWALL2 (225 BY 1);
          SLAB ON GRADE FLOOR:
                FACING (E) FLOOR1 (3145.5 BY 1);
          ROOF:
                FACING (S) ROOF1 (3145.5 BY 1);

          PEOPLE = 44, ALL ZONES PEOPLE;
          LIGHTS = 14.34, CLINIC LIGHTS AND EQUIPMENT;
          ELECTRIC EQUIPMENT = 8.64, CLINIC LIGHTS AND EQUIPMENT;
          CONTROLS = CLINIC CONTROLS, 15 HEATING, 104.8 COOLING;
     END ZONE;
     ZONE 8 "X-RAY":
          ORIGIN: (0,0,0);
          INTERNAL MASS: PWALL1 (1404 BY 1);
          INTERNAL MASS: PWALL2 (36 BY 1);
          SLAB ON GRADE FLOOR:
                FACING (E) FLOOR1 (974 BY 1);
          ROOF:
                FACING (S) ROOF1 (974 BY 1);
          PEOPLE = 5, ALL ZONES PEOPLE;
          LIGHTS = 3.96, CLINIC LIGHTS AND EQUIPMENT;
          ELECTRIC EQUIPMENT = 28.87, CLINIC LIGHTS AND EQUIPMENT;
          CONTROLS = CLINIC CONTROLS, 0 HEATING, 149 COOLING;
     END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM 1 "MAIN FAN SYSTEM" SERVING ZONES 1,2,3,8;
FOR ZONE 1:
       EXHAUST AIR VOLUME = 1000;
       SUPPLY AIR VOLUME = 2190;
END;
     FOR ZONE 2:
          SUPPLY AIR VOLUME = 6360;
     END ZONE;
     FOR ZONE 3:

          EXHAUST AIR VOLUME = 600;
          SUPPLY AIR VOLUME = 2980;
     END ZONE;
     FOR ZONE 8:
          SUPPLY AIR VOLUME = 829;
     END;
  EQUIPMENT SCHEDULES:
          SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
          HEATING COIL OPERATION = OFF, FROM 01MAY THRU 25SEP;
```

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 END;
OTHER SYSTEM PARAMETERS:
     SUPPLY FAN EFFICIENCY = .38;
      HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
      HOT DECK CONTROL SCHEDULE = (120 AT 10, 80 AT 70);
      COLD DECK CONTROL = FIXED SET POINT;
      COLD DECK TEMPERATURE = 60.;
    COLD DECK THROTTLING RANGE = 5;
      MIXED AIR CONTROL = FIXED AMOUNT;
      OUTSIDE AIR VOLUME = 4114.;
END;
COOLING COIL DESIGN PARAMETERS:
      COIL TYPE = DX;
      ENTERING AIR DRY BULB TEMPERATURE = 87.6;
      ENTERING AIR WET BULB TEMPERATURE = 70.3;
      LEAVING AIR DRY BULB TEMPERATURE = 61.;
      LEAVING AIR WET BULB TEMPERATURE = 59.;
      AIR FACE VELOCITY = 514.6;
      AIR VOLUME FLOW RATE = 15760;
      BAROMETRIC PRESSURE = 405;

      LEAVING REFRIGERANT TEMPERATURE=45.;
      ENTERING REFRIGERANT TEMPERATURE = 45;
      TOTAL COOLING LOAD = 600;
      NUMBER OF TUBE CIRCUITS=20;
END;
DX CONDENSING UNIT PARAMETERS:
      RPWRCD(.40349281,.21287191,.39339793);
      DESIGN SATURATED SUCTION TEMPERATURE=40;
      DESIGN SATURATED CONDENSING TEMPERATURE=130;
      DESIGN FULL LOAD POWER RATIO=.351;
      DX CONDENSING UNIT CAPACITY=600;
END DX CONDENSING UNIT PARAMETERS;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;
     PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
      EQUIPMENT SELECTION:
         1 BOILER OF SIZE 100;
      END EQUIPMENT SELECTION;
     END PLANT;
  END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

```
**
**               INPUT FILE = DCNCC4I
**
**      THIS IS THE DENTAL CLINIC USED IN THE BLAST VALIDATION  (7/16/81)
**      STUDIES.   IT HAS BEEN SIMPLIFIED TO A FOUR ZONE MODEL.
**      THE WALL/FLOOR/PEOPLE/ETC. HAVE ALL BEEN LUMPED TOGETHER.
**      THE FAN SYSTEM HAS NOT BEEN MODIFIED.  THE CRAWL
**      SPACE IS INCLUDED IN THE MODEL.
**
**      THE SYSTEM OPERATION SCHEDULE WAS CHANGED FROM DEFAULT    (7/8/81)
**      TO "OFF" AND THE HEATING COIL SCHEDULE WAS CHANGED FROM
**      THAT FOR FT. HOOD TO THAT USED FOR RALEIGH, NC.
**
**      THE AMOUNT OF HEATING AND COOLING IS SET TO KEEP THE
**      BUILDING TEMPERATURE BETWEEN 66 AND 78F ALL YEAR.
**
BEGIN INPUT;
RUN CONTROL:  NEW ZONES,
              NEW AIR SYSTEMS,
           PLANT,
  UNITS(OUT=ENGLISH),
REPORTS(ZONE LOADS,SYSTEM,SYSTEM LOADS,COIL LOADS,PLANT LOADS, WALLS, ZONE);
      TEMPORARY LOCATION:
    RALNC = (LAT = 35.83, LONG = 78.83, TZ = 5);
      END;
      TEMPORARY DESIGN DAYS:
         RALNCSUM = (HIGH= 92, LOW= 71, WB= 75, DATE= 21JUL,
                     PRES= 405, WS= 440, DIR= 270,
                     CLEARNESS= 1, WEEKDAY);

         RALNCWIN = (HIGH= 29, LOW= 14, WB= 10, DATE= 21JAN,
                     PRES= 405, WS= 1320, DIR= 325,
                     CLEARNESS= .1, WEEKEND);
      END;
  TEMPORARY SCHEDULE (OFF):
     SUNDAY THRU SATURDAY = (00 TO 24 - OFF),
     HOLIDAY = SUNDAY;
  END;
TEMPORARY SCHEDULE (ALL ZONES PEOPLE):
      MONDAY THRU FRIDAY = (17 TO 07 - 0.,.5,.94,.92,.79,.52,.56,.75,
                                 .68,.61,.28),
      SATURDAY THRU SUNDAY = (00 TO 24 - 0),
      HOLIDAY = SUNDAY;
END;
TEMPORARY SCHEDULE (CLINIC LIGHTS AND EQUIPMENT):
 MONDAY THRU FRIDAY = (19 TO 07 - .34,.58,.98,.98,.98,.84,
                            .72,.91,.98,.95,.79,.40,.40),
      SATURDAY THRU SUNDAY = (00 TO 24 - .34),
      HOLIDAY = SUNDAY;
END;
TEMPORARY CONTROLS (CLINIC CONTROLS):
      PROFILES:
        CONSTANT = (1 AT 66, 0 AT 68, -.125 AT 70, -1 AT 140);
      SCHEDULES:
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          MONDAY THRU SUNDAY = (00 TO 24 - CONSTANT),
          HOLIDAY = SUNDAY;
END;
TEMPORARY WALLS:
      EWALL1 = (BRICK - FACE 4 IN,

                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                CONCRETE - CEMENT MORTAR 1/2 IN,
                C3 - 4 IN HW CONCRETE BLOCK,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL1 = (BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      PWALL2 = (C8 - 8 IN HW CONCRETE BLOCK,
                B1 - AIRSPACE RESISTANCE,
                BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN),
      CPWALL = (A1 - 1 IN STUCCO,
                C10 - 8 IN HW CONCRETE,
                E1 - 3 / 4 IN PLASTER OR GYP BOARD);
END;
TEMPORARY ROOFS:
      ROOF1 = (E2 - 1/ 2 IN SLAG OR STONE,
               E3 - 3/8 IN FELT AND MEMBRANE,
               A3 - STEEL SIDING,
               E4 - CEILING AIRSPACE,
               B4 - 3 IN INSULATION,
               E5 - ACOUSTIC TILE),
      CPCEIL =(FINISH FLOORING - TILE 1/16 IN,
               C10 - 8 IN HW CONCRETE,
               B1 - AIRSPACE RESISTANCE,
               B2 - 1 IN INSULATION);
END;

TEMPORARY FLOORS:
      FLOOR1 = (B2 - 1 IN INSULATION,
                B1 - AIRSPACE RESISTANCE,
                C10 - 5 IN HW CONCRETE,
                FINISH FLOORING - TILE 1/16 IN),
      CPFLOOR = (DIRT 12 IN);
END;
TEMPORARY DOORS:
      WINDOW PANEL = (GLASS - HEAT ABSORBING PLATE 1/ 2 IN,
                      INSULATION - CELLULAR GLASS 2 IN,
                      C3 - 4 IN HW CONCRETE BLOCK,
                      BUILDING BOARD - GYPSUM PLASTER 1 / 2 IN);
END;
   PROJECT= "DENTAL CLINIC - FT BRAGG NC";
   LOCATION = RALNC;
    GROUND TEMPERATURE = (59,60,61,62,66,70,74,72,69,66,64,61);
    WEATHER TAPE FROM 01JAN THRU 31DEC;
BEGIN BUILDING DESCRIPTION;
      NORTH AXIS = 0.;
```

```
      DIMENSIONS: H = 9., N = 0, E = 90, S = 180, W = 270;
     SOLAR DISTRIBUTION = -1;
**
CRAWL SPACE 1000 "CRAWL SPACE":
      ORIGIN:(0,0,-2.5);
      NORTH AXIS = 0;
   CRAWL SPACE CEILING:
      STARTING AT (0,0,2.5) FACING (S) CPCEIL (92 BY 102);
   SLAB ON GRADE FLOOR:
      STARTING AT (0,102,0) FACING (S) CPFLOOR (92 BY 102);

   BASEMENT WALLS:
      STARTING AT (0,0,0) FACING (S) CPWALL (92 BY 2.5),
      STARTING AT (92,0,0) FACING (E) CPWALL (102 BY 2.5),
      STARTING AT (92,102,0) FACING (N) CPWALL (92 BY 2.5),
      STARTING AT (0,102,0) FACING (W) CPWALL (102 BY 2.5);
END ZONE;
**
    ZONE 1 "NORTH EXTERIOR ZONES (1,2)":
         ORIGIN: (0,0,0);
         EXTERIOR WALLS:
              FACING (N) EWALL1 (45 BY H)
                   WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                        (13.3 BY 4.25) AT (0,4)
                   WITH DOOR OF TYPE WINDOW PANEL
                        (13.3 BY 4) AT (0,0)
                   WITH OVERHANG (98 BY 3) AT (-50,H),
              FACING (W) EWALL1 (19 BY H)
                   WITH OVERHANG (108 BY 3) AT (-3,H);
         INTERNAL MASS: PWALL1 (643.5 BY 1);
         INTERNAL MASS: PWALL2 (171 BY 1);
         FLOOR OVER CRAWL SPACE:
              FACING (E) FLOOR1 (855 BY 1);
         ROOF:
              FACING (S) ROOF1 (855 BY 1);
         PEOPLE = 6, ALL ZONES PEOPLE;
         LIGHTS = 7.91, CLINIC LIGHTS AND EQUIPMENT;
         ELECTRIC EQUIPMENT = 17.06, CLINIC LIGHTS AND EQUIPMENT;
         GAS EQUIPMENT = 5, CLINIC LIGHTS AND EQUIPMENT;
         CONTROLS = CLINIC CONTROLS, 0 HEATING, 140.4 COOLING;

      END ZONE;
    ZONE 2 "EXTERIOR ZONES (3,9,10)":
         ORIGIN: (0,0,0);
         EXTERIOR WALLS:
              FACING (S) EWALL1 (92 BY H)
                   WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                        (43.4 BY 4.25) AT (0,4)
                   WITH DOORS OF TYPE WINDOW PANEL
                        (26.6 BY 4) AT (0,0)
                   WITH OVERHANG (98 BY 3) AT (-3,H),
              FACING (E) EWALL1 (83.5 BY H)
                   WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                        (30.4 BY 4.25) AT (0,4)
                   WITH DOOR OF TYPE WINDOW PANEL
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```
                    (19.95 BY 4) AT (0,0)
               WITH OVERHANGS (108 BY 3) AT (-3,H),
          FACING (W) EWALL1 (83.5 BY H)
               WITH WINDOWS OF TYPE SINGLE PANE TINTED WINDOW
                    (30.44 BY 4.25) AT (0,4)
               WITH DOOR OF TYPE WINDOW PANEL
                    (19.95 BY 4) AT (0,0)
               WITH OVERHANG (108.5 BY 3) AT (-3,H);
     INTERNAL MASS: PWALL1 (2466 BY 1);
     INTERNAL MASS: PWALL2 (135 BY 1);
     FLOOR OVER CRAWL SPACE:
          FACING (E) FLOOR1 (3622 BY 1);
     ROOF:
          FACING (S) ROOF1 (3622 BY 1);
     PEOPLE = 30, ALL ZONES PEOPLE;

     LIGHTS = 22.83, CLINIC LIGHTS AND EQUIPMENT;
     ELECTRIC EQUIPMENT = 10.23, CLINIC LIGHTS AND EQUIPMENT;
     CONTROLS = CLINIC CONTROLS, 30 HEATING, 207.1 COOLING;
END ZONE;
**
   ZONE 3 "INTERIOR (ZONES 4,5,6,7)":
     ORIGIN: (0,0,0);
          INTERNAL MASS: PWALL1 (5089.5 BY 1);
          INTERNAL MASS: PWALL2 (225 BY 1);
     FLOOR OVER CRAWL SPACE:
          FACING (E) FLOOR1 (3145.5 BY 1);
     ROOF:
          FACING (S) ROOF1 (3145.5 BY 1);
     PEOPLE = 44, ALL ZONES PEOPLE;
     LIGHTS = 14.34, CLINIC LIGHTS AND EQUIPMENT;
     ELECTRIC EQUIPMENT = 9.64, CLINIC LIGHTS AND EQUIPMENT;
     CONTROLS = CLINIC CONTROLS, 15 HEATING, 104.8 COOLING;
   END ZONE;
   ZONE 8 "X-RAY":
     ORIGIN: (0,0,0);
     INTERNAL MASS: PWALL1 (1404 BY 1);
     INTERNAL MASS: PWALL2 (36 BY 1);
     FLOOR OVER CRAWL SPACE:
          FACING (E) FLOOR1 (974 BY 1);
     ROOF:
          FACING (S) ROOF1 (974 BY 1);
     PEOPLE = 5, ALL ZONES PEOPLE;
     LIGHTS = 3.96, CLINIC LIGHTS AND EQUIPMENT;
     ELECTRIC EQUIPMENT = 28.87, CLINIC LIGHTS AND EQUIPMENT;

     CONTROLS = CLINIC CONTROLS, 0 HEATING, 149 COOLING;
   END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
MULTIZONE SYSTEM 1 "MAIN FAN SYSTEM" SERVING ZONES 1,2,3,8;
FOR ZONE 1:
      EXHAUST AIR VOLUME = 1000;
      SUPPLY AIR VOLUME = 2190;
END;
```

```
    FOR ZONE 2:
         SUPPLY AIR VOLUME = 6360;
    END ZONE;
    FOR ZONE 3:
         EXHAUST AIR VOLUME = 600;
         SUPPLY AIR VOLUME = 2980;
    END ZONE;
    FOR ZONE 8:
         SUPPLY AIR VOLUME = 829;
    END;
 EQUIPMENT SCHEDULES:
         SYSTEM OPERATION = OFF, FROM 01JAN THRU 31DEC;
         HEATING COIL OPERATION = OFF, FROM 01MAY THRU 25SEP;
 END;
OTHER SYSTEM PARAMETERS:
      SUPPLY FAN EFFICIENCY = .38;
        HOT DECK CONTROL = OUTSIDE AIR CONTROLLED;
        HOT DECK CONTROL SCHEDULE = (120 AT 10, 80 AT 70);
        COLD DECK CONTROL = FIXED SET POINT;
        COLD DECK TEMPERATURE = 60.;

    COLD DECK THROTTLING RANGE = 5;
        MIXED AIR CONTROL = FIXED AMOUNT;
        OUTSIDE AIR VOLUME = 4114.;
END;
COOLING COIL DESIGN PARAMETERS:
        COIL TYPE = DX;
        ENTERING AIR DRY BULB TEMPERATURE = 87.6;
        ENTERING AIR WET BULB TEMPERATURE = 70.3;
        LEAVING AIR DRY BULB TEMPERATURE = 61.;
        LEAVING AIR WET BULB TEMPERATURE = 59.;
        AIR FACE VELOCITY = 514.6;
        AIR VOLUME FLOW RATE = 15760;
        BAROMETRIC PRESSURE = 405;
        LEAVING REFRIGERANT TEMPERATURE=45.;
        ENTERING REFRIGERANT TEMPERATURE = 45;
        TOTAL COOLING LOAD = 600;
        NUMBER OF TUBE CIRCUITS=20;
END;
DX CONDENSING UNIT PARAMETERS:
        RPWRCD(.40349281,.21287191,.39339793);
        DESIGN SATURATED SUCTION TEMPERATURE=40;
        DESIGN SATURATED CONDENSING TEMPERATURE=130;
        DESIGN FULL LOAD POWER RATIO=.351;
        DX CONDENSING UNIT CAPACITY=600;
END DX CONDENSING UNIT PARAMETERS;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
BEGIN CENTRAL PLANT DESCRIPTION;
      PLANT 1 "DUMMY PLANT" SERVING ALL SYSTEMS;
       EQUIPMENT SELECTION;
          1 BOILER OF SIZE 100;
       END EQUIPMENT SELECTION;
      END PLANT;
```

```
   END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

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